Exhibit A

to

Complaint
for Patent Infringement

The ’054 Patent

US009198054B2

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Cuff et al.

(10) **Patent No.: US 9,198,054 B2**
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(54) **AGGREGATE LOCATION DYNOMETER (ALD)**

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(73) Assignee: **TeleCommunication Systems, Inc.**, Annapolis, MD (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

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(51) **Int. Cl.**
H04W 24/00 (2009.01)
H04W 24/08 (2009.01)
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CPC ***H04W 24/00*** (2013.01); ***H04W 4/023*** (2013.01); ***H04W 24/08*** (2013.01); ***H04W 64/006*** (2013.01); *H04L 67/22* (2013.01); *H04W 4/22* (2013.01)

(58) **Field of Classification Search**
CPC H04W 64/006; H04W 4/22; H04W 4/02; H04W 4/028; H04W 76/007; H04W 4/023; H04W 24/00; H04W 4/025; H04W 24/08; H04W 64/00; H04L 67/22
USPC 455/404.1, 404.2, 456.1–457, 405, 455/456.6, 456.2, 456.3, 456.5, 435.1, 455/435.2
See application file for complete search history.

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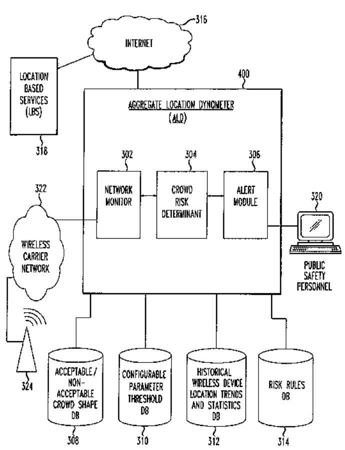
(57) **ABSTRACT**

An Aggregate Location Dynometer (ALD) in a physical wireless network alerts to a problematic crowd risk using location based services (LBS). An Aggregate Location Dynometer (ALD) comprises a Network Monitor, a Crowd Risk Determinant and an Alert Module. The Network Monitor monitors wireless traffic for a potential viral event, associated with a formation of a plurality of wireless devices. The Crowd Risk Determinant requests location information associated with a plurality of wireless devices in a given area regarding a respective viral event. The Crowd Risk Determinant determines if the viral event also indicates a crowd safety risk, based on the shape and movement of observed wireless devices. The Alert Module triggers an alert of an impending crowd problem when crowd risk is above a given threshold. Historical databases are empirically determined and maintained in the Aggregate Location Dynometer (ALD) for use in viral event and crowd risk assessment.

14 Claims, 7 Drawing Sheets



(51) **Int. Cl.**

H04W 64/00	(2009.01)
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FIG. 1

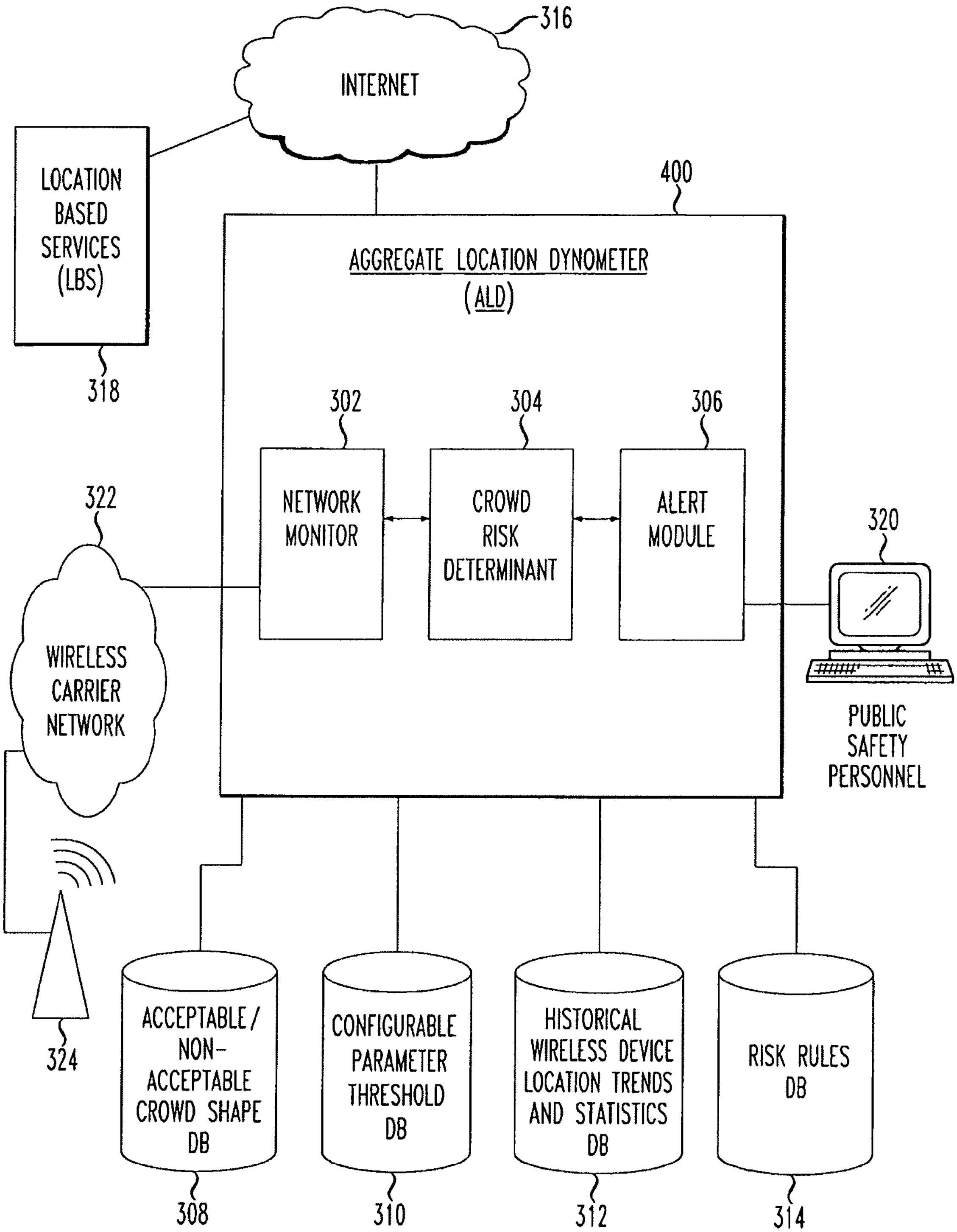

316
INTERNET
LOCATION BASED SERVICES (LBS)
318
400
AGGREGATE LOCATION DYNOMETER (ALD)
302
304
306
NETWORK MONITOR
CROWD RISK DETERMINANT
ALERT MODULE
322
WIRELESS CARRIER NETWORK
320
PUBLIC SAFETY PERSONNEL
324
ACCEPTABLE/ NON-ACCEPTABLE CROWD SHAPE DB
CONFIGURABLE PARAMETER THRESHOLD DB
HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB
RISK RULES DB
308
310
312
314

FIG. 2

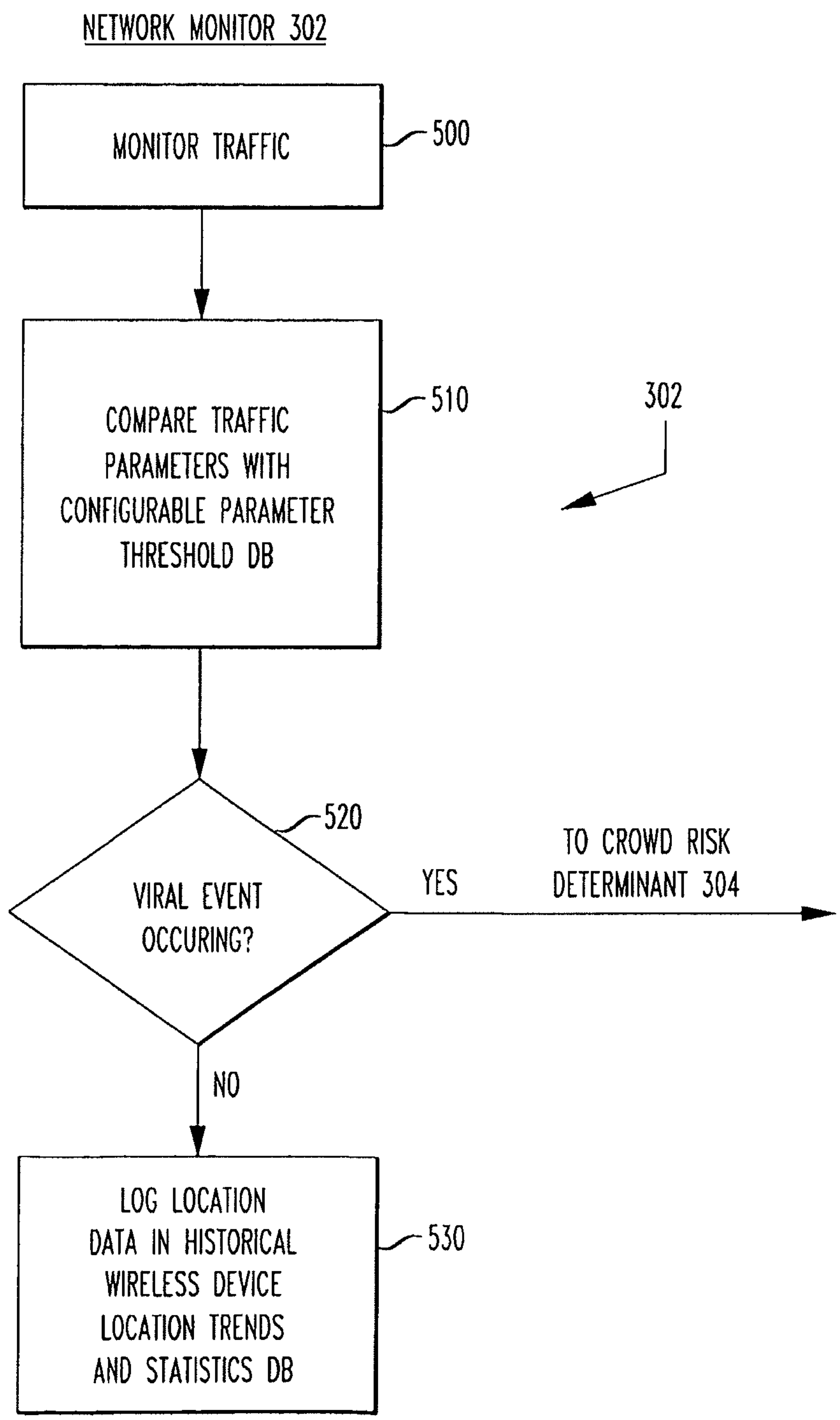

NETWORK MONITOR 302
MONITOR TRAFFIC
500
COMPARE TRAFFIC PARAMETERS WITH CONFIGURABLE PARAMETER THRESHOLD DB
510
302
VIRAL EVENT OCCURING?
520
YES
TO CROWD RISK DETERMINANT 304
NO
LOG LOCATION DATA IN HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB
530

FIG. 3

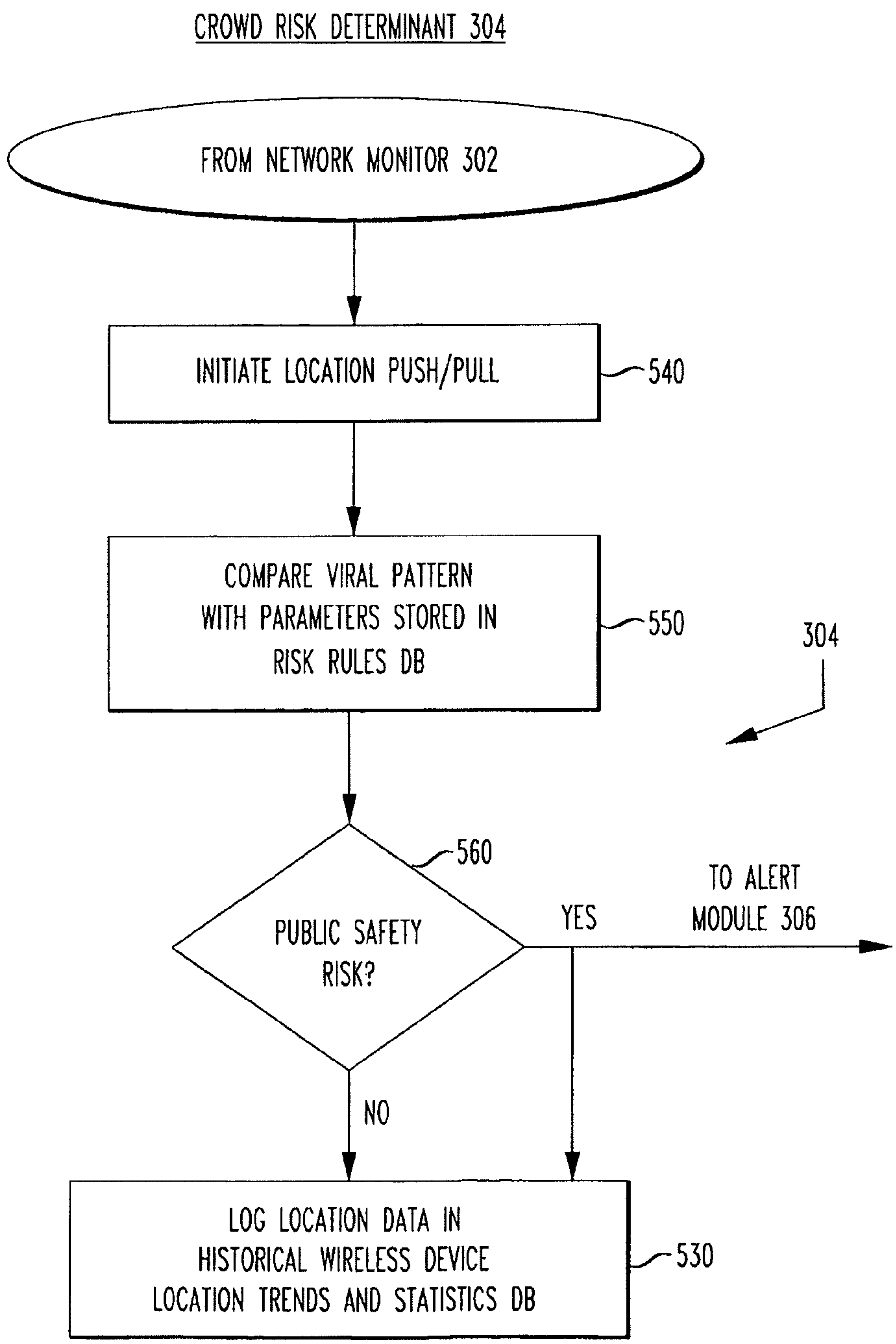
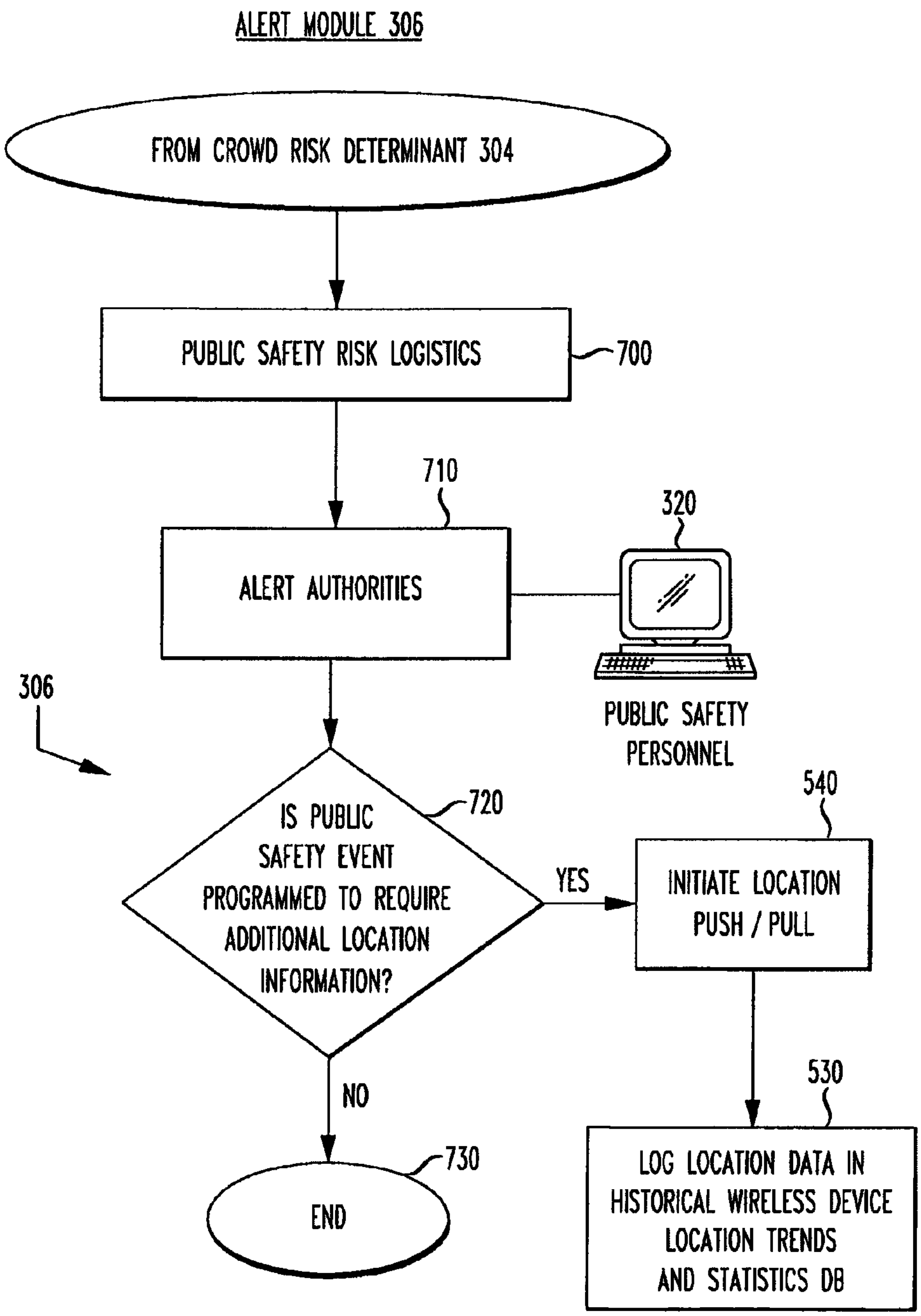

CROWD RISK DETERMINANT 304
FROM NETWORK MONITOR 302
INITIATE LOCATION PUSH/PULL
540
COMPARE VIRAL PATTERN WITH PARAMETERS STORED IN RISK RULES DB
550
304
560
PUBLIC SAFETY RISK?
YES
TO ALERT MODULE 306
NO
LOG LOCATION DATA IN HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB
530

FIG. 4


ALERT MODULE 306
FROM CROWD RISK DETERMINANT 304
PUBLIC SAFETY RISK LOGISTICS
700
710
ALERT AUTHORITIES
320
PUBLIC SAFETY PERSONNEL
306
IS PUBLIC SAFETY EVENT PROGRAMMED TO REQUIRE ADDITIONAL LOCATION INFORMATION?
720
YES
540
INITIATE LOCATION PUSH / PULL
NO
530
730
END
LOG LOCATION DATA IN HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB

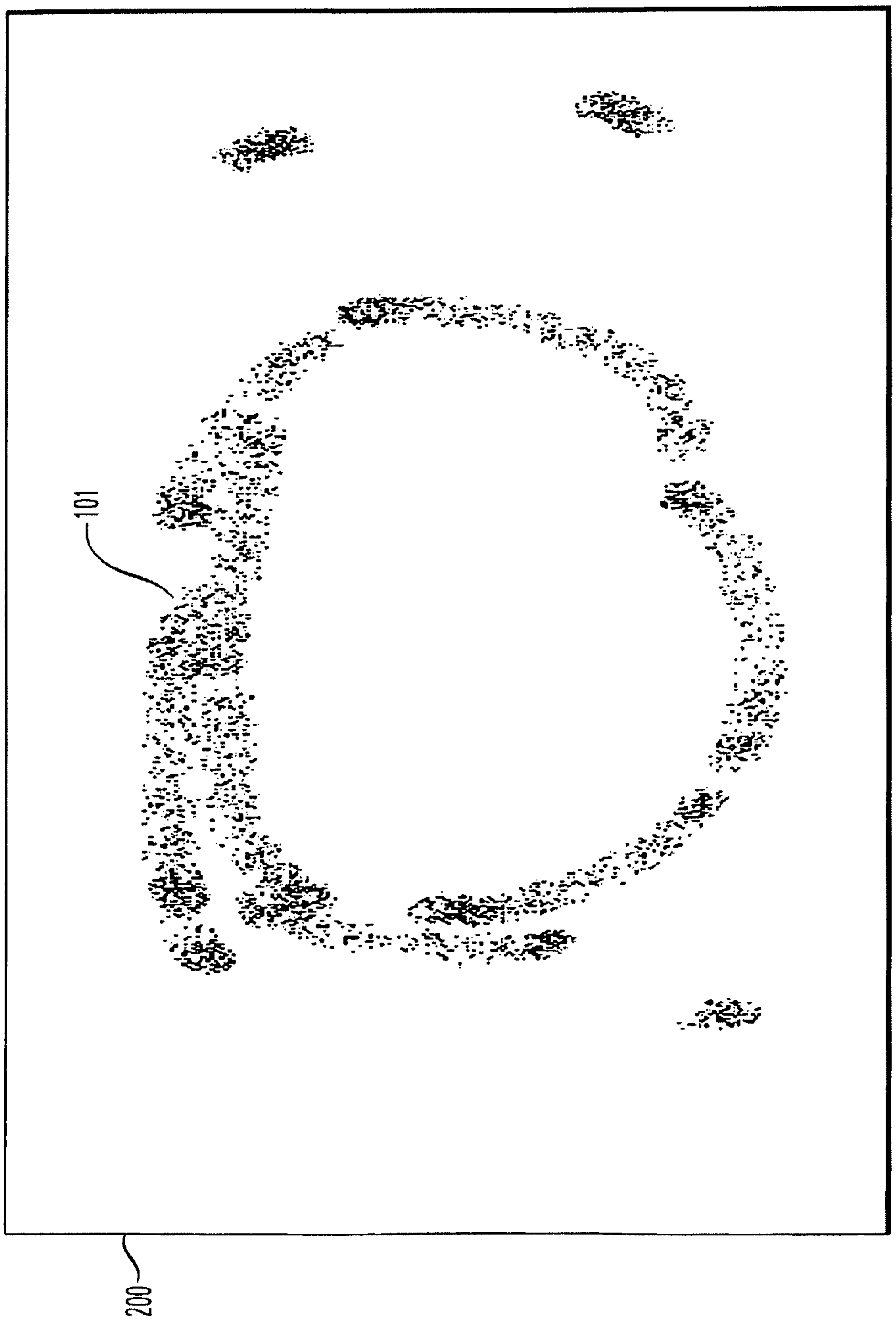


FIG. 5

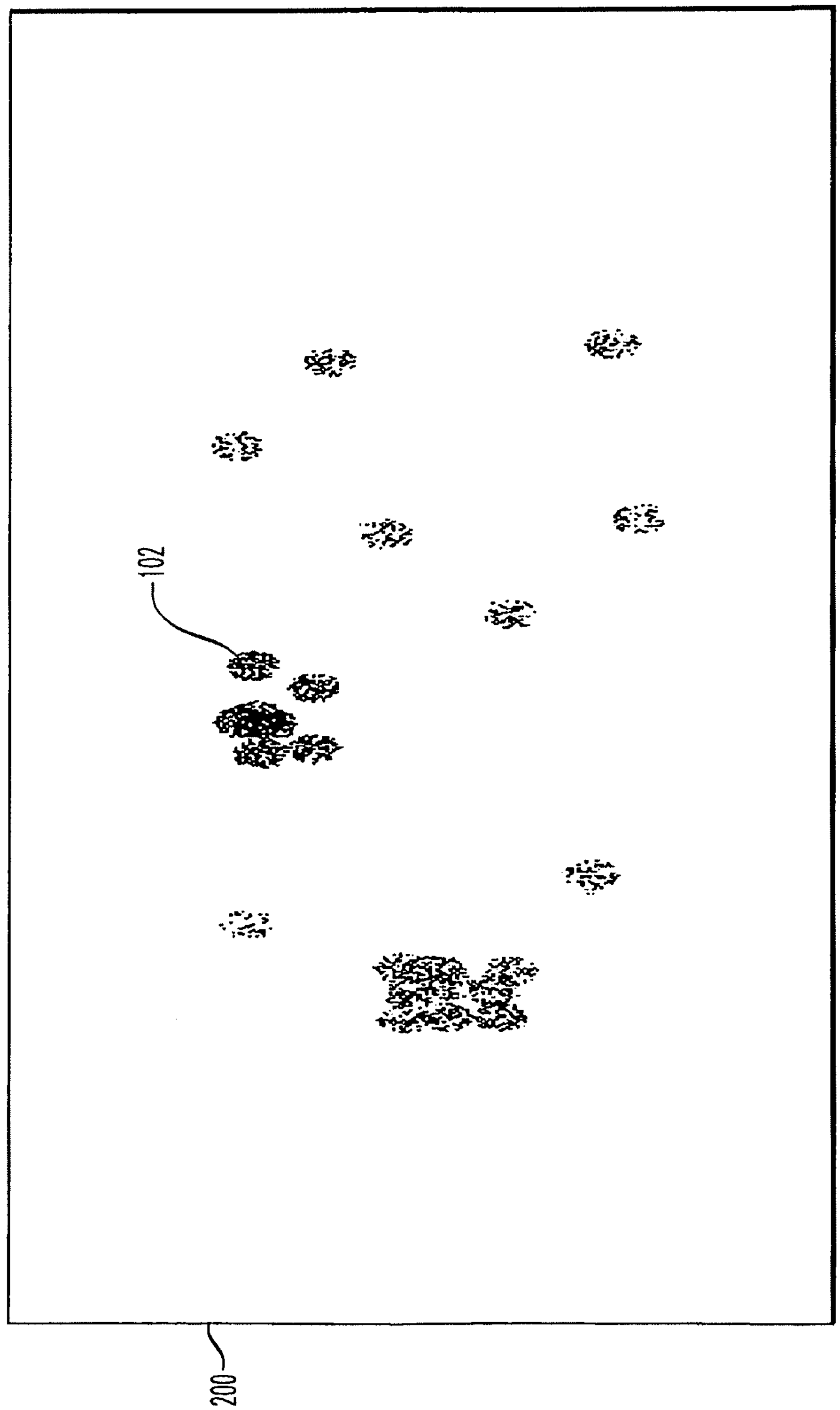


FIG. 6

FIG. 7

AGGREGATE LOCATION DYNOMETER (ALD)

The present application is a continuation of U.S. application Ser. No. 13/317,996 entitled "Aggregate Location Dynometer (ALD)", filed on Nov. 2, 2011, now U.S. Pat. No. 8,649,806; which claims priority from U.S. Provisional Application No. 61/573,112, entitled "Aggregate Location Dynometer (ALD)", filed Sep. 2, 2011, the entirety of both of which are expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to wireless telecommunications. More particularly, it relates to cell location services, cell network trafficking and analysis of location information.

2. Background of Related Art

Location based applications obtain a geographic position of a particular wireless device and provide services accordingly. Location based services (LBS) prevail in today's market due to an incorporation of tracking technology in handheld devices.

Location based pull services allow a wireless device user to locate another wireless device. Current location services are generally focused on individual wireless device user applications.

SUMMARY OF THE INVENTION

In accordance with the principles of the present invention, a method of alerting to a problematic crowd risk in a given geographical location, comprises an Aggregate Location Dynometer (ALD). The Aggregate Location Dynometer (ALD) utilizes location based services (LBS) to analyze aggregate location information pertaining to a multitude of wireless devices, to detect potential crowd risks.

An Aggregate Location Dynometer (ALD) resides in a physical network server, in accordance with the present invention, and comprises three main components: a Network Monitor, a Crowd Risk Determinant, and an Alert Module.

The Network Monitor monitors a wireless network for indication of a possible impending viral event, in accordance with the principles of the present invention. In particular, the Network Monitor utilizes location based services (LBS) to monitor the formation of a plurality of wireless devices at a given point in a wireless network, e.g., a given base station (BS). The Network Monitor compares obtained traffic parameters pertaining to monitored wireless traffic, with historical traffic parameters having to do with crowd risk determination, to determine if a viral event may be occurring or impending. A snapshot look at current location data collected by the Network Monitor is subsequently logged in an appropriate historical database.

In accordance with the principles of the present invention, the Crowd Risk Determinant analyzes location information to determine if a viral event triggered by the Network Monitor, also indicates a crowd safety risk. In particular, the Crowd Risk Determinant initiates a location request to obtain location information pertaining to a multitude of wireless devices in a given area, regarding a viral event that has been triggered by the Network Monitor. The Crowd Risk Determinant compares the viral pattern formed by the shape and movement of wireless devices in locations observed, with predetermined risk rules to determine if the viral event is also a crowd safety risk. The observed viral pattern is subsequently logged in an appropriate historical database.

The Alert Module, in accordance with the principles of the present invention, alerts proper authorities in an event of a crowd safety risk. The Crowd Risk Determinant triggers the Alert Module to alert of an impending crowd problem when crowd risk has exceeded a given threshold.

The Aggregate Location Dynometer (ALD) utilizes historical databases, in accordance with the present invention, to maintain location-based information indicating possible viral events associated with a plurality of wireless devices. Historical databases include an Acceptable/Non-Acceptable Crowd Shape database, a Configurable Parameter Threshold database, a Historical Wireless Device Location Trends database, and a Risk Rules database.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present invention will become apparent to those skilled in the art from the following description with reference to the drawings, in which:

FIG. **1** depicts an exemplary Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **2** depicts the flow of an exemplary Network Monitor of the Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **3** depicts the flow of an exemplary Crowd Risk Determinant of the Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **4** depicts the flow of an exemplary Alert Module of the Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **5** denotes first exemplary Aggregate Location Dynometer (ALD) location results, in accordance with the principles of the present invention.

FIG. **6** denotes second exemplary Aggregate Location Dynometer (ALD) location results, in accordance with the principles of the present invention.

FIG. **7** denotes third exemplary Aggregate Location Dynometer (ALD) location results, in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Thus far, location capabilities have been concerned with locating an individual wireless device. Yet, there is such a vast abundance of individuals populating the nation's major cities. The present inventor has appreciated the benefits of using location based services (LBS) to obtain sets of aggregate location data corresponding to a number and pattern of wireless devices within an area, region, city, etc. of interest.

The present invention introduces an Aggregate Location Dynometer (ALD), an analytical server utilizing location based services (LBS) on a network to predict public safety risks, e.g., the unexpected impending formation of a flash mob, or a riot, etc.

The Aggregate Location Dynometer (ALD) analyzes a bird's-eye view of people formation, presuming those individuals possess respective handheld wireless devices that permit collection of current location information, whether that current location information be obtained from the wireless devices themselves, and/or from a network-based location server.

In accordance with the principles of the present invention, the Aggregate Location Dynometer (ALD) predicts public safety risk in a given geographical area through evaluation of the positioning and movement of wireless devices. The

Aggregate Location Dynometer (ALD) monitors wireless device network traffic to predict an impending viral event. If a possible impending viral event is sensed from a general monitoring of wireless traffic, the Aggregate Location Dynometer (ALD) may request impending viral location information pertaining to clusters of wireless devices in a vicinity of the possible event, to more accurately assess crowd risk.

Crowd risk is assessed based upon given wireless network traffic parameters such as the number of wireless devices in communication with a given base station (e.g., a density), the shape formed by representations of the individual locations of the densest areas where active wireless devices are currently located, and/or the movement of the wireless devices within the region as defined.

Markers, each representing a wireless device at a given location at a given time, may be displayed on a display of the Aggregate Location Dynometer (ALD). The markers may represent wireless devices served within the given region, whether actively communicating with another wireless device, or merely sensed as present.

The present invention preferably provides an alert of a possible impending crowd related public safety risk in real time, as the crowd risk arises, informing emergency personnel as early as possible, even before such event is consummated.

FIG. **1** depicts an exemplary Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, an Aggregate Location Dynometer (ALD) **400** determines crowd safety risk with the help of location based services (LBS) **318**, as depicted in FIG. **1**.

The Aggregate Location Dynometer (ALD) **400** is generally based in a server in a wireless network **322**. Three main components form the Aggregate Location Dynometer (ALD) **400**: a Network Monitor **302**, a Crowd Risk Determinant **304**, and an Alert Module **306**.

The Network Monitor **302** begins the risk determination process of the Aggregate Location Dynometer (ALD) **400** by monitoring the network for indication of a possible viral event, in accordance with the principles of the present invention. Determination of a viral event is the first step in the escalation-based response of the Aggregate Location Dynometer (ALD) **400**.

The Crowd Risk Determinant **304** assesses location information pertaining to a possible viral event triggered by the Network Monitor **302**. The Crowd Risk Determinant **304** determines if a viral event also indicates a public safety risk.

The Alert Module **306** performs predetermined responsive measures to alert appropriate public safety personnel **320** in the event of a possible or probable or current public safety risk.

Historical databases are empirically determined and maintained in the Aggregate Location Dynometer (ALD) **400** for use in crowd risk assessment. The historical databases preferably store sets of aggregate current location information pertaining to trackable wireless devices. Exemplary historical databases accessible by the Aggregate Location Dynometer (ALD) **400** include but are not limited to a Historical Wireless Device Location Trends and Statistics database **312**, a Configurable Parameter Threshold database **310**, a Risk Rules database **314**, and an Acceptable/Non-Acceptable Crowd Shape database **308**.

The Historical Wireless Device Location Trends and Statistics database **312**, as shown in FIG. **1**, preferably stores sets of instantaneous aggregate location information obtained over a period of time. Data stored in the Historical Wireless Device Location Trends and Statistics database **312** provides empirical evaluation of crowd activities used to detect a crowd trend. The Aggregate Location Dynometer (ALD) **400** preferably uses data stored in the Historical Wireless Device Location Trends and Statistics database **312** to determine if a current situation is considered to be 'normal' to the monitored area, or abnormal, triggering a viral event. The data maintained in the Historical Wireless Device Location Trends and Statistics database **312** is preferably refreshed over time.

The Configurable Parameter Threshold database **310**, as depicted in FIG. **1**, preferably comprises a set of configurable location-based parameters and thresholds including density, clustering, spread, geographical boundary, motion trends, and/or special events occurring in particular areas. The Configurable Parameter Threshold database **310** can also include non-location based parameters such as time of day and/or message content. The parameters stored in the Configurable Parameter Threshold database **310** are accessed by the Network Monitor **302** to assist in detecting a viral event.

The Risk Rules database **314**, as shown in FIG. **1**, preferably comprises a set of configurable location-based parameters and thresholds including density, clustering, spread, geographical boundary, motion trends, and/or special events occurring in particular areas. The Risk Rules database **314** can also include non-location based parameters such as time of day and/or message content. The parameters stored in the Risk Rules database **314** are accessed by the Crowd Risk Determinant **304** to assist in determining if a viral event also indicates a public safety risk.

The Acceptable/Non-Acceptable Crowd Shape database **308**, as shown in FIG. **1**, holds empirically determined past, historical cluster information regarding acceptable and/or non-acceptable past shape formations of clustered wireless devices. Specific shape parameters stored in the Acceptable/Non-Acceptable Crowd Shape database **308** are accessed by the Crowd Risk Determinant **304** to assist in determining if a viral event also indicates a public safety risk.

A viral event is the first state of alarm in the multi-state risk determination process of the Aggregate Location Dynometer (ALD) **400**. A viral event is defined as occurring when one or more predefined parameter thresholds have been surpassed, as determined in the exemplary embodiment in the Network Monitor **302**. The occurrence of a viral event does not necessarily infer a definite public safety risk. Instead, a viral event triggers the Crowd Risk Determinant **304** to further analyze a potentially malignant event more closely. For example, the Crowd Risk Determinant **304** provides a closer inspection of aggregate current location information, e.g., via use of a location-based push/pull service. A match of more detailed location information to a historical pattern leading to crowd risk may determine that a particular viral event also indicates a likely public safety risk.

A public safety risk confirms a compromise in crowd safety, e.g., the impending formation of a flash mob, or a riot, etc. Determination of a public safety risk triggers the Alert Module **306** to implement proper public safety response services.

The Network Monitor **302** begins the risk determination process of the Aggregate Location Dynometer (ALD) **400**, by monitoring the network for indication of a possible viral event, in accordance with the principles of the present invention.

Moreover, the Network Monitor **302** retrieves subsequent sets of instantaneous aggregate location information. Location information triggered by the Network Monitor **302** may be portrayed in the form of snapshots displayed on a display of the Aggregate Location Dynometer (ALD) **400**. Snapshots

by the Network Monitor **302** comprise markers, each representing the location of individual wireless devices within a given region being monitored.

The Network Monitor **302** preferably obtains information regarding the number of wireless devices in a geographical area, at a given time, supported by a particular wireless network carrier (e.g., the number of wireless devices sending messages over a wireless network via a particular base station (BS) **324**). The Network Monitor **302** uses predefined parameters and thresholds to determine if the monitored network indicates that a viral event may be occurring or impending (e.g., surpassed parameter thresholds possibly indicative of an excessive number and/or use of wireless devices for a given area, cell tower, etc.).

For instance, a Maximum Number of Devices parameter may indicate the maximum number of wireless devices that may be present within range of a particular base station (BS) **324** at a given time before a possible viral event is triggered. The Maximum Number of Devices parameter may be set manually, or empirically determined (e.g., the average number of devices present at a particular base station (BS) **324** over a course of time, as determined by historical data stored in the Historical Wireless Device Location Trends and Statistics database **312**).

The Network Monitor **302** triggers a possible viral event if a predefined parameter threshold has been surpassed (e.g., a given density of current location markers each representing a separate wireless device, or a directed convergence of at least two highly dense clusters of markers toward each other at a significant rate of speed is or has occurred, etc.).

The Network Monitor **302** preferably tallies the number of wireless devices in each instantaneous aggregate location snapshot that is captured. Predetermined parameters and thresholds are used to assess the number (e.g., the density) of wireless devices in a particular area to determine whether or not a possible viral event is occurring.

The Maximum Number of Devices parameter may alternatively be set to indicate the maximum number of wireless devices that may be present in an instantaneous aggregate location snapshot before a possible viral event is triggered. If the number of devices present in a given snapshot exceeds the Maximum Value of Devices parameter established for the respective location, a viral event may be triggered.

The Network Monitor **302** also preferably tallies the difference in the number of wireless devices in a given area, from one consecutive instantaneous aggregate location snapshot to the next. If the difference in the number of wireless devices from snapshot to snapshot exceeds a predefined value in a number of consecutive snapshots for a given area, base station, etc., then a viral event may be triggered. Thresholds for such a predefined Maximum Difference in Number of Wireless Devices parameter and a predefined Interval of Consecutive Snapshots parameter may be set manually, or empirically determined (e.g., the average difference in number of devices in consecutive instantaneous aggregate location snapshots capturing a particular area, e.g., a number of square feet, a particular base station (BS), etc., over a course of time, supported by a particular network carrier, as recorded in the Historical Wireless Device Location Trends and Statistics database **312**).

FIG. **2** depicts the flow of an exemplary Network Monitor **302** of the Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, as shown in step **500** of FIG. **2**, the Network Monitor **302** preferably continuously, or at least periodically or intermittently, monitors network traffic.

In step **510**, monitored wireless data traffic is inspected for the presence of abnormal events, e.g., excessive volume for the time of day, etc. Configurable thresholds for the monitored parameters may be dynamic over the course of the day and even for traffic for any given tower or base station. The configurable thresholds for monitored parameters may be stored in the Configurable Parameter Threshold database **310**.

As shown in step **520**, if one or more parameter thresholds are exceeded, a viral event may be triggered. In response, the Network Monitor **302** triggers the Crowd Risk Determinant **304** to perform a location-based push/pull service to determine the location of each trackable wireless device within a particular geographic area (e.g., communicating through given base stations or antennas).

When parameter thresholds are not surpassed, indicating that a viral event is not occurring, location data may be logged in the Historical Wireless Device Location Trends and Statistics database **312**, as depicted in step **530**. Location data logged in the Historical Wireless Device Location Trends and Statistics database **312** may be used by the Crowd Risk Determinant **304** for future analyses of crowd risk.

FIG. **3** depicts the flow of an exemplary Crowd Risk Determinant **304** of the Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, the Crowd Risk Determinant **304** performs a location-based push/pull service to obtain location information pertaining to trackable wireless devices in a given area regarding a respective viral event triggered by the Network Monitor **302**, as shown in step **540** of FIG. **3**.

In step **550**, collected location data is analyzed to assess the viral event that is occurring. The Crowd Risk Determinant **304** uses bounds and priorities set forth in the Risk Rules database **314** to determine if a possible viral event indicates a public safety risk. A viral pattern may or may not imply public safety risk. In step **560**, if a public safety risk is determined, the Crowd Risk Determinant **304** triggers the Alert Module **306** to take responsive public safety measures. Location data associated with a public safety risk is logged **530** in the Historical Wireless Device Location Trends and Statistics database **312**.

If the Crowd Risk Determinant **304** confirms that a particular viral event does not indicate a public safety risk, the Aggregate Location Dynometer (ALD) **400** is triggered to routinely log location data **530** in the Historical Wireless Device Location Trends and Statistics database **312** for potential future analyses.

Determination of a public safety risk in the Crowd Risk Determinant **304** triggers the Alert Module **306** to implement proper public safety response services. An Alert Module **306** is the final step in the risk determination process of the Aggregate Location Dynometer (ALD) **400**.

FIG. **4** depicts the flow of an exemplary Alert Module **306** of the Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, as shown in step **700** of FIG. **4**, the Alert Module **306** is triggered by the Crowd Risk Determinant **304** and supplied the predetermined conditions constituting how to handle a determined public safety risk.

The Alert Module **306** immediately alerts the proper authorities **320** in the presence of a public safety risk, as depicted in step **710**.

Subsequent aggregate data collections may be made by the Alert Module **306** in step **720**. A particular public safety event may be programmed to result in multiple aggregate location data collections, set to occur at specific intervals. Moreover, a particular risk determination result may be configured to act

as a triggered push/pull service **540** to acquire additional location data. Subsequent location information is routinely logged in the Historical Wireless Devices Location Trends and Statistics database **530**.

Configurable parameters are maintained in the Risk Rules database **314** to assist the Crowd Risk Determinant **304** in determining if location information pertaining to a viral event indicates a likely public safety risk. Factors for risk determination include but are not limited to the shape a cluster of location markers representing individual wireless devices of given density is forming, whether or not markers are spreading out or coming together, and/or at what rate of change a cluster of wireless devices is moving. Factors for risk determination also include the behavior of collective XY location coordinates of the most dense clusters of wireless devices, to where the most dense clusters of wireless devices of concern are moving, and/or whether or not a cluster of wireless devices in a particular location makes sense given the time of day.

For instance, empirical data may indicate that it is unusual for there to be a large number of wireless devices present downtown after business hours, or after a time when local bars and clubs have closed for the night. In this case, a configurable threshold may be set for a combination of location and time of day parameters (e.g., to articulate the number of wireless devices that must be present within a defined downtown region, after a given hour) to trigger a public safety risk. A configurable parameter threshold (e.g., specifying the number of wireless devices capable of inhabiting a particular geographic expanse or particular shape of device formation, or a given density within that region) may manually or empirically be set. If a parameter threshold is surpassed, the Crowd Risk Determinant **304** informs the Alert Module **306** of the development of a public safety risk.

The shape of a cluster of wireless devices may often offer significant clues to crowd risk potential. When location information is collected, the best-fit shape of dense clusters formed by accumulation of wireless devices in a given area may be determined. The best-fit shape of a cluster of wireless devices may be compared against data contained in the historical Acceptable/Non-Acceptable Crowd Shape database **308** to determine danger potential. Different thresholds may be set for like parameters based on varying location.

FIG. **5** denotes first exemplary Aggregate Location Dynometer (ALD) **400** location results, in accordance with the principles of the present invention.

In particular, the large oval shape **101** formed by markers representing individual wireless devices in the given geographical area **200** shown in FIG. **5**, may be interpreted as a group of individuals enjoying a sporting event in a stadium. Factors to consider are time of day and scheduled events. The example in FIG. **5** uses precise location.

FIG. **6** denotes second exemplary Aggregate Location Dynometer (ALD) **400** location results, in accordance with the principles of the present invention.

In particular, the pattern **102** in the geographical area **200** shown in FIG. **6** may be interpreted as cell sites pertaining to trackable individuals, assuming most individuals carry wireless devices. The same pattern may mean different things at different hours of the day. The exemplary location result shown in FIG. **6** uses coarse location.

FIG. **7** denotes third exemplary Aggregate Location Dynometer (ALD) **400** location results, in accordance with the principles of the present invention.

In particular, the crescent shape **103** in the geographical area **200** shown in FIG. **7** is recognized as a pattern to be wary of. This crescent shape may represent a variety of different occurrences (e.g., a protest in front of a given location such as a court house, a famous author at a bookstore, etc.). The exemplary location result shown in FIG. **7** uses precise location.

A rate-based parameter threshold may also or alternatively be set to define an acceptable rate at which wireless devices would otherwise normally inhabit a geographic area. For instance, if over a certain number of wireless devices enter an area in under a given amount of time (e.g., if three hundred wireless devices rush into a central pre-defined location in under ten minutes) then a public safety risk may be triggered.

Message content may be analyzed as an attribute for risk determination in response to a viral traffic event. For instance, a determination of the most frequent phrases may be matched against a database of suspected terms (e.g., "meet at the Lincoln Memorial", etc.).

Motion trends are also analyzed to assess crowd risk. The Crowd Risk Determinant **304** preferably determines whether the accumulation of wireless devices is becoming more or less dense about a central location and whether or not this behavior is expected based on trends and configured thresholds established for particular locations.

Precise accuracy of each individual device location is not extremely important in the present invention. Instead, focus lies in the volume, density, shape and movement of data points collected. Serving cell tower locations for each wireless device may be sufficient to satisfy initial triggering requirements for a possible viral event. The Aggregate Location Dynometer (ALD) **400** is concerned with aggregate location data as opposed to data involving individual device locations. Data regarding parameters such as special events, geographical boundaries, motion trends, density, clustering, spread, time of day and/or message content relating to trackable wireless devices are recorded in the Historical Wireless Device Location Trends and Statistics database **312**, as opposed to exact locations of specific wireless devices. Anonymity regarding precise locations of specific wireless devices alleviates some concern surrounding the privacy of individuals during location based services (LBS), as used within the present invention.

An Aggregate Location Dynometer (ALD) **400** has benefit to entities other than emergency management and crowd risk assessment parties. For instance, the present invention may also be used to estimate location trends in cities, to rank areas such as parks and beaches by volume of visitors, and even to peg traffic patterns. Historical crowd data need not represent a public safety issue, e.g., it may merely relate to city planning or disaster recovery. Thus, data collected while scanning for crowd risk provides cities, states and government with valuable information.

Though, preferably all wireless devices in a given area would be monitored for crowd gathering tendencies, it is also within the principles of the present invention to monitor only those devices by the relevant wireless carrier providing Location Dynometer (ALD) **400** services.

The present invention greatly benefits police, fire and general emergency response personnel **320** desiring early warning about possible crowd related risks, e.g., riots. Moreover, the present invention is intended to combat nefarious cell technology to spawn mobs and riots without resorting to network restrictions.

While the invention makes use of the current location data of preferably all wireless devices within a given region, area, etc., the invention also preferably makes distinction between the current mode of operation of the wireless devices being analyzed for a possible public safety risk. For instance, analy-

sis of the density, shape, movement, etc. in determining a possible public safety risk may analyze only wireless devices in active mode.

While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention.

What is claimed is:

1. An aggregate location dynometer in a physical wireless network server, said aggregate location dynometer comprising:

a network monitor to monitor a wireless network for an indication of a viral event;

a location aggregator to obtain a location of each of a plurality of wireless devices associated with said viral event;

a crowd risk determinant, triggered by said network monitor, to determine a crowd risk based on an aggregation of said location of each of said plurality of wireless devices associated with said viral event; and

an alert module to initiate an alert message relating to a public safety risk determined from an analysis of said viral event.

2. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

a historical database maintaining a geographic region associated with said viral event.

3. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **2**, wherein said historical databases comprises:

a plurality of acceptable crowd shapes, a crowd shape being defined by said aggregation of said location of each of said plurality of wireless devices associated with said viral event.

4. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **2**, wherein said historical databases comprises:

a plurality of non-acceptable crowd shapes, a crowd shape being defined by said aggregation of said location of each of said plurality of wireless devices associated with said viral event.

5. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **2**, wherein said historical databases comprises:

a configurable parameter defining a threshold of a crowd shape becoming unacceptable and thus said crowd risk.

6. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **2**, wherein said historical databases comprises:

a plurality of crowd shape trends based on historical wireless device locations during previous viral events.

7. A method of alerting to a problematic crowd risk based on location based services (LBS), comprising:

monitoring wireless traffic for a forming viral event associated with a plurality of physical wireless devices within a given region;

initiating location requests to a physical location server to obtain a current location of each of said plurality of physical wireless devices;

forming a crowd shape based on an aggregation of said current location of each of said plurality of physical wireless devices;

determining a crowd risk of said crowd based on said crowd shape of said current location of each of said plurality of physical wireless devices; and

triggering a crowd alert message when said determined crowd risk is above a given threshold.

8. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **7**, wherein:

said crowd risk of said crowd is further determined based on a movement of said crowd shape.

9. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **7**, wherein said monitoring wireless traffic comprises:

monitoring wireless traffic at a given point in a wireless network; and

comparing a given traffic parameter associated with said obtained current location of each of said plurality of physical wireless devices, with a historical traffic parameter associated with a previous problematic crowd formation.

10. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **9**, wherein:

said given point is at a given base station in said wireless network.

11. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **9**, further comprising:

logging a snapshot formation created by said current location of each of said plurality of physical wireless devices.

12. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **7**, wherein said initiating location requests comprises:

initiating a location request for each of said plurality of physical wireless devices.

13. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **7**, further comprising:

comparing a viral pattern of respective locations of said plurality of wireless devices to predetermined risk rules.

14. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **13**, further comprising:

logging said viral pattern.

* * * * *

Exhibit B

to

Complaint
for Patent Infringement

The ’158 Patent

US009402158B2

(12) **United States Patent**
Cuff et al.

(10) **Patent No.: US 9,402,158 B2**
(45) **Date of Patent: *Jul. 26, 2016**

(54) **AGGREGATE LOCATION DYNOMETER (ALD)**

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(73) Assignee: **Telecommunication Systems, Inc.**, Annapolis, MD (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/885,136**

(22) Filed: **Oct. 16, 2015**

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Related U.S. Application Data

(63) Continuation of application No. 14/176,691, filed on Feb. 10, 2014, now Pat. No. 9,198,054, which is a continuation of application No. 13/317,996, filed on Nov. 2, 2011, now Pat. No. 8,649,806.

(60) Provisional application No. 61/573,112, filed on Sep. 2, 2011.

(51) **Int. Cl.**
H04W 4/00 (2009.01)
H04W 4/02 (2009.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04W 4/023*** (2013.01); ***H04L 67/22*** (2013.01); ***H04W 4/028*** (2013.01); ***H04W 4/22*** (2013.01); ***H04W 24/00*** (2013.01); ***H04W 24/08*** (2013.01); ***H04W 64/006*** (2013.01)

(58) **Field of Classification Search**
CPC H04W 4/22; H04W 4/02; H04W 4/028; H04W 76/007; H04W 4/023; H04W 64/006; H04W 4/025; H04M 11/04; H04M 2242/04; G06Q 30/0201
USPC 455/414.1, 456.1–456.6, 457, 404.1, 455/404.2
See application file for complete search history.

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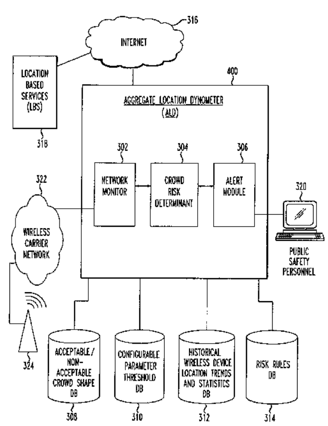
Primary Examiner — Olumide T Ajibade Akonai
(74) *Attorney, Agent, or Firm* — Tarolli, Sundheim, Covell & Tummino LLP

(57) **ABSTRACT**

An Aggregate Location Dynometer (ALD) in a physical wireless network alerts to a problematic crowd risk using location based services (LBS). An Aggregate Location Dynometer (ALD) comprises a Network Monitor, a Crowd Risk Determinant and an Alert Module. The Network Monitor monitors wireless traffic for a potential viral event, associated with a formation of a plurality of wireless devices. The Crowd Risk Determinant requests location information associated with a plurality of wireless devices in a given area regarding a respective viral event. The Crowd Risk Determinant determines if the viral event also indicates a crowd safety risk, based on the shape and movement of observed wireless devices. The Alert Module triggers an alert of an impending crowd problem when crowd risk is above a given threshold. Historical databases are empirically determined and maintained in the Aggregate Location Dynometer (ALD) for use in viral event and crowd risk assessment.

16 Claims, 7 Drawing Sheets



(51) **Int. Cl.**

H04L 29/08	(2006.01)
H04W 24/08	(2009.01)
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FIG. 1

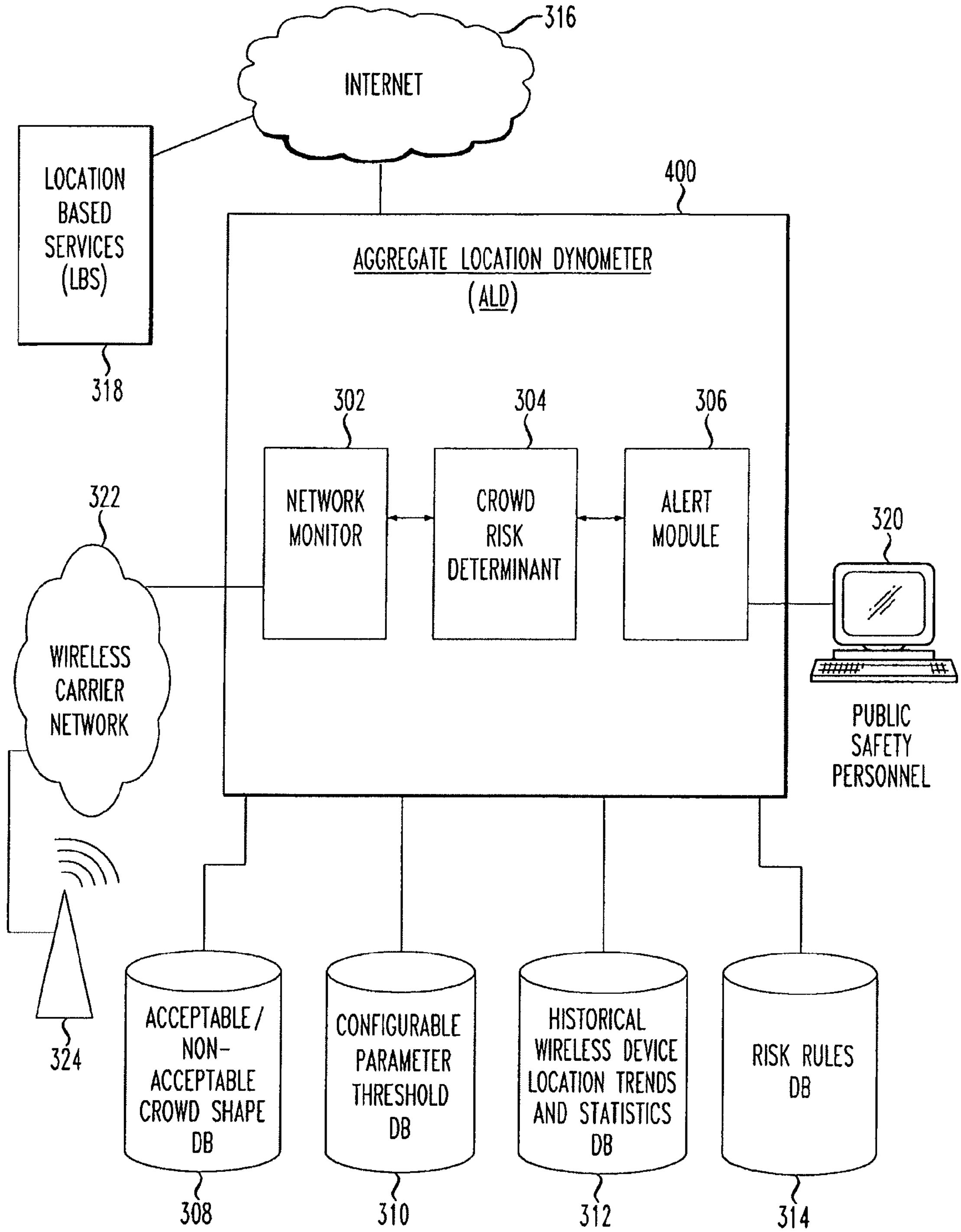

316
INTERNET
LOCATION BASED SERVICES (LBS)
318
400
AGGREGATE LOCATION DYNOMETER (ALD)
302
304
306
NETWORK MONITOR
CROWD RISK DETERMINANT
ALERT MODULE
322
WIRELESS CARRIER NETWORK
320
PUBLIC SAFETY PERSONNEL
324
ACCEPTABLE / NON-ACCEPTABLE CROWD SHAPE DB
CONFIGURABLE PARAMETER THRESHOLD DB
HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB
RISK RULES DB
308
310
312
314

FIG. 2

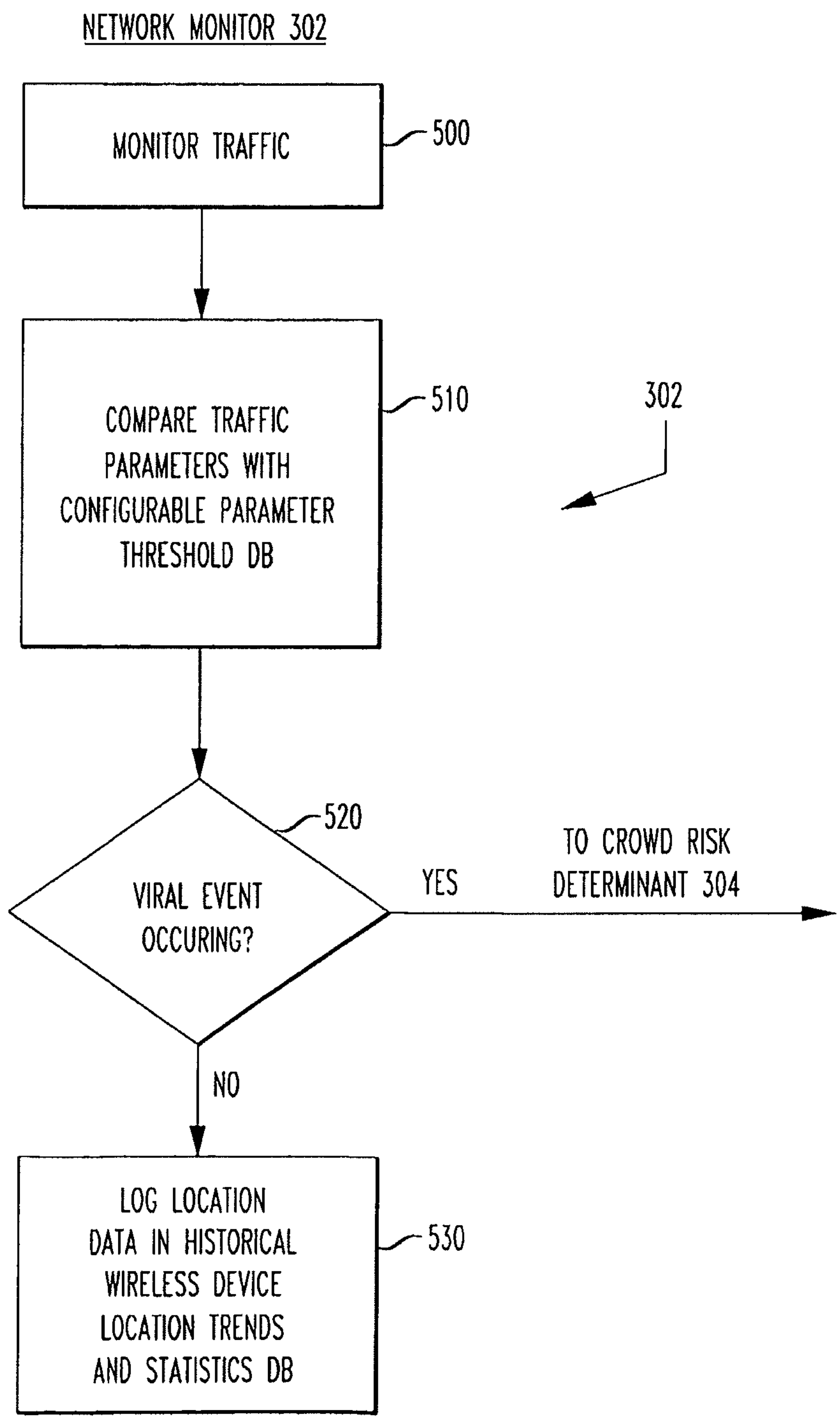

NETWORK MONITOR 302
MONITOR TRAFFIC
500
COMPARE TRAFFIC PARAMETERS WITH CONFIGURABLE PARAMETER THRESHOLD DB
510
302
VIRAL EVENT OCCURING?
520
YES
TO CROWD RISK DETERMINANT 304
NO
LOG LOCATION DATA IN HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB
530

FIG. 3

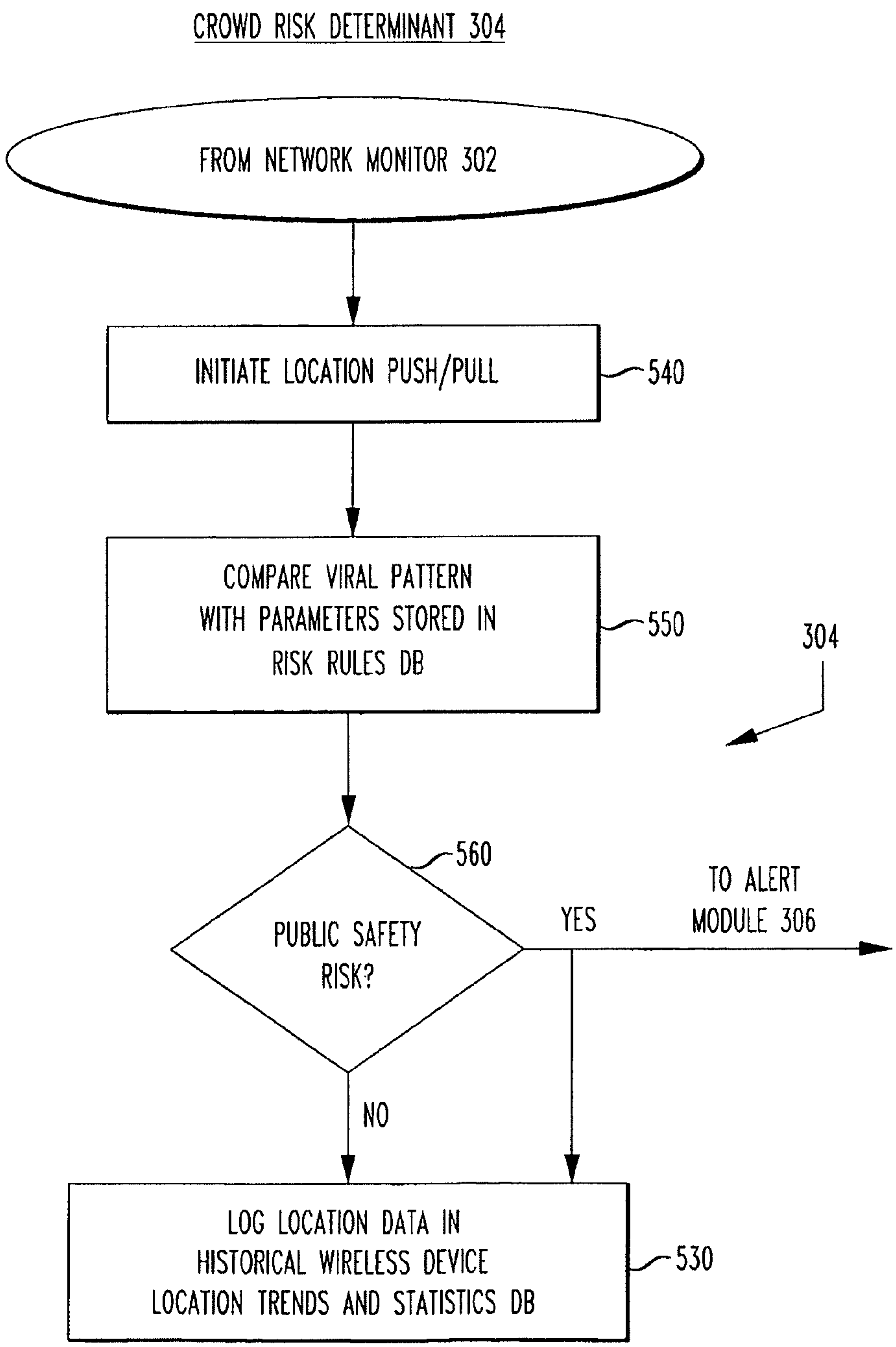
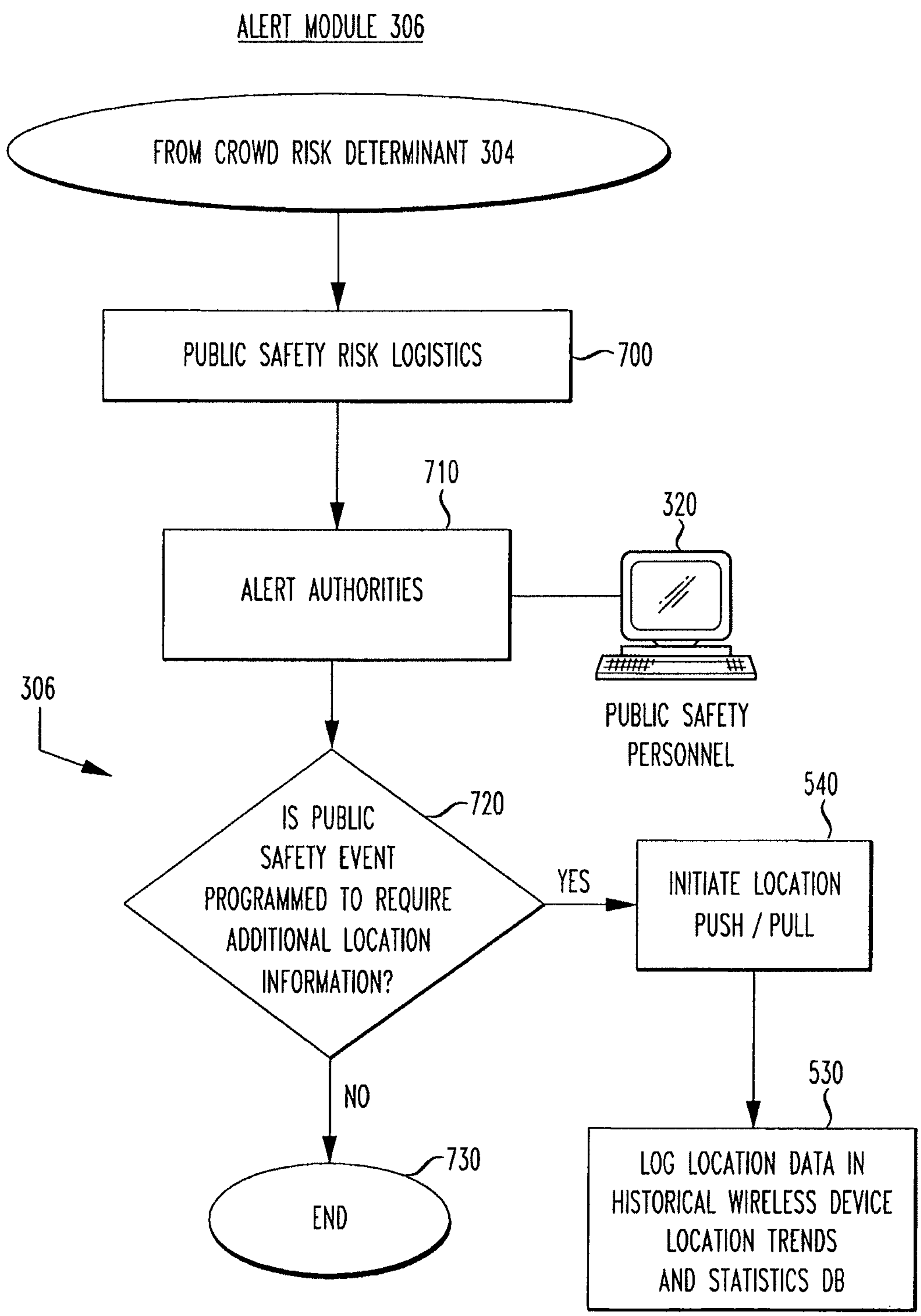

CROWD RISK DETERMINANT 304
FROM NETWORK MONITOR 302
INITIATE LOCATION PUSH/PULL
540
COMPARE VIRAL PATTERN WITH PARAMETERS STORED IN RISK RULES DB
550
304
560
PUBLIC SAFETY RISK?
YES
TO ALERT MODULE 306
NO
LOG LOCATION DATA IN HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB
530

FIG. 4


ALERT MODULE 306
FROM CROWD RISK DETERMINANT 304
PUBLIC SAFETY RISK LOGISTICS
700
710
320
ALERT AUTHORITIES
PUBLIC SAFETY PERSONNEL
306
540
IS PUBLIC SAFETY EVENT PROGRAMMED TO REQUIRE ADDITIONAL LOCATION INFORMATION?
720
YES
INITIATE LOCATION PUSH / PULL
NO
530
730
END
LOG LOCATION DATA IN HISTORICAL WIRELESS DEVICE LOCATION TRENDS AND STATISTICS DB

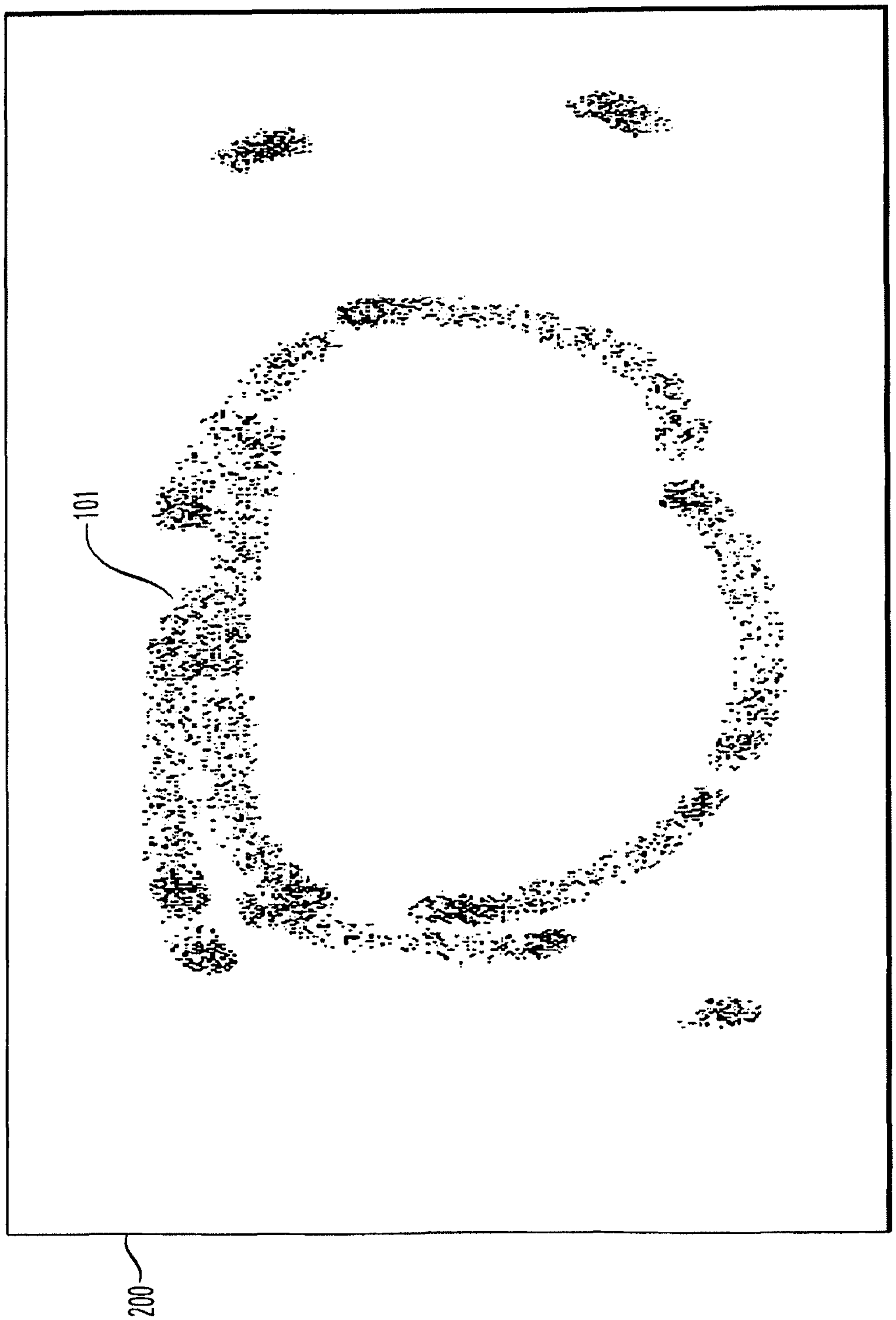


FIG. 5

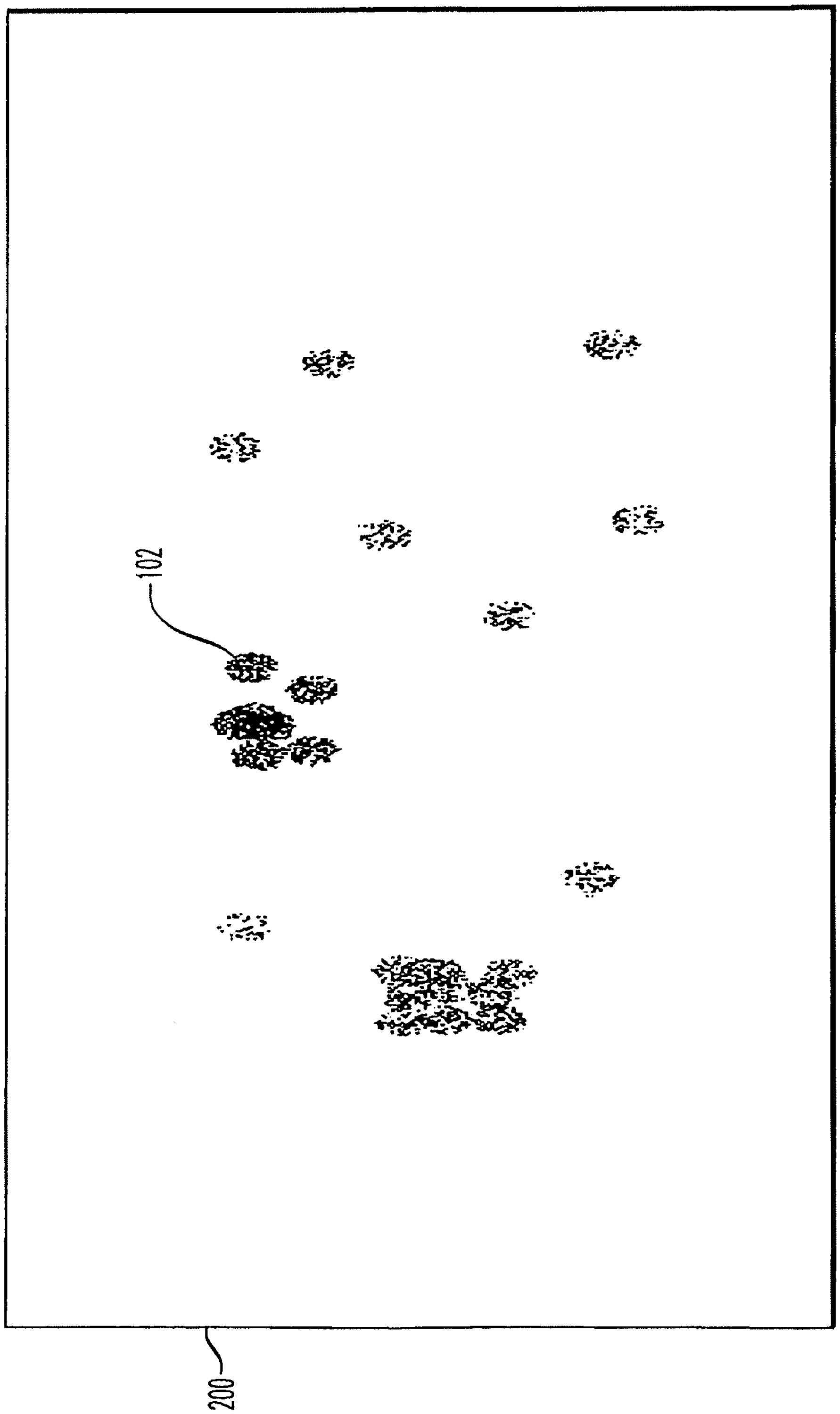


FIG. 6

FIG. 7

AGGREGATE LOCATION DYNOMETER (ALD)

The present application is a continuation of U.S. application Ser. No. 14/176,691, entitled "Aggregate Location Dynometer (ALD)", filed on Feb. 10, 2014; which is a continuation of U.S. application Ser. No. 13/317,996 entitled "Aggregate Location Dynometer (ALD)", filed on Nov. 2, 2011, now U.S. Pat. No. 8,649,806; which claims priority from U.S. Provisional Application No. 61/573,112, entitled "Aggregate Location Dynometer (ALD)", filed Sep. 2, 2011, the entirety of all three of which are expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to wireless telecommunications. More particularly, it relates to cell location services, cell network trafficking and analysis of location information.

2. Background of Related Art

Location based applications obtain a geographic position of a particular wireless device and provide services accordingly. Location based services (LBS) prevail in today's market due to an incorporation of tracking technology in handheld devices.

Location based pull services allow a wireless device user to locate another wireless device. Current location services are generally focused on individual wireless device user applications.

SUMMARY OF THE INVENTION

In accordance with the principles of the present invention, a method of alerting to a problematic crowd risk in a given geographical location, comprises an Aggregate Location Dynometer (ALD). The Aggregate Location Dynometer (ALD) utilizes location based services (LBS) to analyze aggregate location information pertaining to a multitude of wireless devices, to detect potential crowd risks.

An Aggregate Location Dynometer (ALD) resides in a physical network server, in accordance with the present invention, and comprises three main components: a Network Monitor, a Crowd Risk Determinant, and an Alert Module.

The Network Monitor monitors a wireless network for indication of a possible impending viral event, in accordance with the principles of the present invention. In particular, the Network Monitor utilizes location based services (LBS) to monitor the formation of a plurality of wireless devices at a given point in a wireless network, e.g., a given base station (BS). The Network Monitor compares obtained traffic parameters pertaining to monitored wireless traffic, with historical traffic parameters having to do with crowd risk determination, to determine if a viral event may be occurring or impending. A snapshot look at current location data collected by the Network Monitor is subsequently logged in an appropriate historical database.

In accordance with the principles of the present invention, the Crowd Risk Determinant analyzes location information to determine if a viral event triggered by the Network Monitor, also indicates a crowd safety risk. In particular, the Crowd Risk Determinant initiates a location request to obtain location information pertaining to a multitude of wireless devices in a given area, regarding a viral event that has been triggered by the Network Monitor. The Crowd Risk Determinant compares the viral pattern formed by the shape and movement of wireless devices in locations observed, with predetermined

risk rules to determine if the viral event is also a crowd safety risk. The observed viral pattern is subsequently logged in an appropriate historical database.

The Alert Module, in accordance with the principles of the present invention, alerts proper authorities in an event of a crowd safety risk. The Crowd Risk Determinant triggers the Alert Module to alert of an impending crowd problem when crowd risk has exceeded a given threshold.

The Aggregate Location Dynometer (ALD) utilizes historical databases, in accordance with the present invention, to maintain location-based information indicating possible viral events associated with a plurality of wireless devices. Historical databases include an Acceptable/Non-Acceptable Crowd Shape database, a Configurable Parameter Threshold database, a Historical Wireless Device Location Trends database, and a Risk Rules database.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present invention will become apparent to those skilled in the art from the following description with reference to the drawings, in which:

FIG. **1** depicts an exemplary Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **2** depicts the flow of an exemplary Network Monitor of the Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **3** depicts the flow of an exemplary Crowd Risk Determinant of the Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **4** depicts the flow of an exemplary Alert Module of the Aggregate Location Dynometer (ALD), in accordance with the principles of the present invention.

FIG. **5** denotes first exemplary Aggregate Location Dynometer (ALD) location results, in accordance with the principles of the present invention.

FIG. **6** denotes second exemplary Aggregate Location Dynometer (ALD) location results, in accordance with the principles of the present invention.

FIG. **7** denotes third exemplary Aggregate Location Dynometer (ALD) location results, in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Thus far, location capabilities have been concerned with locating an individual wireless device. Yet, there is such a vast abundance of individuals populating the nation's major cities. The present inventor has appreciated the benefits of using location based services (LBS) to obtain sets of aggregate location data corresponding to a number and pattern of wireless devices within an area, region, city, etc. of interest.

The present invention introduces an Aggregate Location Dynometer (ALD), an analytical server utilizing location based services (LBS) on a network to predict public safety risks, e.g., the unexpected impending formation of a flash mob, or a riot, etc.

The Aggregate Location Dynometer (ALD) analyzes a bird's-eye view of people formation, presuming those individuals possess respective handheld wireless devices that permit collection of current location information, whether that current location information be obtained from the wireless devices themselves, and/or from a network-based location server.

In accordance with the principles of the present invention, the Aggregate Location Dynometer (ALD) predicts public safety risk in a given geographical area through evaluation of the positioning and movement of wireless devices. The Aggregate Location Dynometer (ALD) monitors wireless device network traffic to predict an impending viral event. If a possible impending viral event is sensed from a general monitoring of wireless traffic, the Aggregate Location Dynometer (ALD) may request impending viral location information pertaining to clusters of wireless devices in a vicinity of the possible event, to more accurately assess crowd risk.

Crowd risk is assessed based upon given wireless network traffic parameters such as the number of wireless devices in communication with a given base station (e.g., a density), the shape formed by representations of the individual locations of the densest areas where active wireless devices are currently located, and/or the movement of the wireless devices within the region as defined.

Markers, each representing a wireless device at a given location at a given time, may be displayed on a display of the Aggregate Location Dynometer (ALD). The markers may represent wireless devices served within the given region, whether actively communicating with another wireless device, or merely sensed as present.

The present invention preferably provides an alert of a possible impending crowd related public safety risk in real time, as the crowd risk arises, informing emergency personnel as early as possible, even before such event is consummated.

FIG. **1** depicts an exemplary Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, an Aggregate Location Dynometer (ALD) **400** determines crowd safety risk with the help of location based services (LBS) **318**, as depicted in FIG. **1**.

The Aggregate Location Dynometer (ALD) **400** is generally based in a server in a wireless network **322**. Three main components form the Aggregate Location Dynometer (ALD) **400**: a Network Monitor **302**, a Crowd Risk Determinant **304**, and an Alert Module **306**.

The Network Monitor **302** begins the risk determination process of the Aggregate Location Dynometer (ALD) **400** by monitoring the network for indication of a possible viral event, in accordance with the principles of the present invention. Determination of a viral event is the first step in the escalation-based response of the Aggregate Location Dynometer (ALD) **400**.

The Crowd Risk Determinant **304** assesses location information pertaining to a possible viral event triggered by the Network Monitor **302**. The Crowd Risk Determinant **304** determines if a viral event also indicates a public safety risk.

The Alert Module **306** performs predetermined responsive measures to alert appropriate public safety personnel **320** in the event of a possible or probable or current public safety risk.

Historical databases are empirically determined and maintained in the Aggregate Location Dynometer (ALD) **400** for use in crowd risk assessment. The historical databases preferably store sets of aggregate current location information pertaining to trackable wireless devices. Exemplary historical databases accessible by the Aggregate Location Dynometer (ALD) **400** include but are not limited to a Historical Wireless Device Location Trends and Statistics database **312**, a Configurable Parameter Threshold database **310**, a Risk Rules database **314**, and an Acceptable/Non-Acceptable Crowd Shape database **308**.

The Historical Wireless Device Location Trends and Statistics database **312**, as shown in FIG. **1**, preferably stores sets of instantaneous aggregate location information obtained over a period of time. Data stored in the Historical Wireless Device Location Trends and Statistics database **312** provides empirical evaluation of crowd activities used to detect a crowd trend. The Aggregate Location Dynometer (ALD) **400** preferably uses data stored in the Historical Wireless Device Location Trends and Statistics database **312** to determine if a current situation is considered to be 'normal' to the monitored area, or abnormal, triggering a viral event. The data maintained in the Historical Wireless Device Location Trends and Statistics database **312** is preferably refreshed over time.

The Configurable Parameter Threshold database **310**, as depicted in FIG. **1**, preferably comprises a set of configurable location-based parameters and thresholds including density, clustering, spread, geographical boundary, motion trends, and/or special events occurring in particular areas. The Configurable Parameter Threshold database **310** can also include non-location based parameters such as time of day and/or message content. The parameters stored in the Configurable Parameter Threshold database **310** are accessed by the Network Monitor **302** to assist in detecting a viral event.

The Risk Rules database **314**, as shown in FIG. **1**, preferably comprises a set of configurable location-based parameters and thresholds including density, clustering, spread, geographical boundary, motion trends, and/or special events occurring in particular areas. The Risk Rules database **314** can also include non-location based parameters such as time of day and/or message content. The parameters stored in the Risk Rules database **314** are accessed by the Crowd Risk Determinant **304** to assist in determining if a viral event also indicates a public safety risk.

The Acceptable/Non-Acceptable Crowd Shape database **308**, as shown in FIG. **1**, holds empirically determined past, historical cluster information regarding acceptable and/or non-acceptable past shape formations of clustered wireless devices. Specific shape parameters stored in the Acceptable/Non-Acceptable Crowd Shape database **308** are accessed by the Crowd Risk Determinant **304** to assist in determining if a viral event also indicates a public safety risk.

A viral event is the first state of alarm in the multi-state risk determination process of the Aggregate Location Dynometer (ALD) **400**. A viral event is defined as occurring when one or more predefined parameter thresholds have been surpassed, as determined in the exemplary embodiment in the Network Monitor **302**. The occurrence of a viral event does not necessarily infer a definite public safety risk. Instead, a viral event triggers the Crowd Risk Determinant **304** to further analyze a potentially malignant event more closely. For example, the Crowd Risk Determinant **304** provides a closer inspection of aggregate current location information, e.g., via use of a location-based push/pull service. A match of more detailed location information to a historical pattern leading to crowd risk may determine that a particular viral event also indicates a likely public safety risk.

A public safety risk confirms a compromise in crowd safety, e.g., the impending formation of a flash mob, or a riot, etc. Determination of a public safety risk triggers the Alert Module **306** to implement proper public safety response services.

The Network Monitor **302** begins the risk determination process of the Aggregate Location Dynometer (ALD) **400**, by monitoring the network for indication of a possible viral event, in accordance with the principles of the present invention.

Moreover, the Network Monitor **302** retrieves subsequent sets of instantaneous aggregate location information. Location information triggered by the Network Monitor **302** may be portrayed in the form of snapshots displayed on a display of the Aggregate Location Dynometer (ALD) **400**. Snapshots by the Network Monitor **302** comprise markers, each representing the location of individual wireless devices within a given region being monitored.

The Network Monitor **302** preferably obtains information regarding the number of wireless devices in a geographical area, at a given time, supported by a particular wireless network carrier (e.g., the number of wireless devices sending messages over a wireless network via a particular base station (BS) **324**). The Network Monitor **302** uses predefined parameters and thresholds to determine if the monitored network indicates that a viral event may be occurring or impending (e.g., surpassed parameter thresholds possibly indicative of an excessive number and/or use of wireless devices for a given area, cell tower, etc.).

For instance, a Maximum Number of Devices parameter may indicate the maximum number of wireless devices that may be present within range of a particular base station (BS) **324** at a given time before a possible viral event is triggered. The Maximum Number of Devices parameter may be set manually, or empirically determined (e.g., the average number of devices present at a particular base station (BS) **324** over a course of time, as determined by historical data stored in the Historical Wireless Device Location Trends and Statistics database **312**).

The Network Monitor **302** triggers a possible viral event if a predefined parameter threshold has been surpassed (e.g., a given density of current location markers each representing a separate wireless device, or a directed convergence of at least two highly dense clusters of markers toward each other at a significant rate of speed is or has occurred, etc.).

The Network Monitor **302** preferably tallies the number of wireless devices in each instantaneous aggregate location snapshot that is captured. Predetermined parameters and thresholds are used to assess the number (e.g., the density) of wireless devices in a particular area to determine whether or not a possible viral event is occurring.

The Maximum Number of Devices parameter may alternatively be set to indicate the maximum number of wireless devices that may be present in an instantaneous aggregate location snapshot before a possible viral event is triggered. If the number of devices present in a given snapshot exceeds the Maximum Value of Devices parameter established for the respective location, a viral event may be triggered.

The Network Monitor **302** also preferably tallies the difference in the number of wireless devices in a given area, from one consecutive instantaneous aggregate location snapshot to the next. If the difference in the number of wireless devices from snapshot to snapshot exceeds a predefined value in a number of consecutive snapshots for a given area, base station, etc., then a viral event may be triggered. Thresholds for such a predefined Maximum Difference in Number of Wireless Devices parameter and a predefined Interval of Consecutive Snapshots parameter may be set manually, or empirically determined (e.g., the average difference in number of devices in consecutive instantaneous aggregate location snapshots capturing a particular area, e.g., a number of square feet, a particular base station (BS), etc., over a course of time, supported by a particular network carrier, as recorded in the Historical Wireless Device Location Trends and Statistics database **312**).

FIG. **2** depicts the flow of an exemplary Network Monitor **302** of the Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, as shown in step **500** of FIG. **2**, the Network Monitor **302** preferably continuously, or at least periodically or intermittently, monitors network traffic.

In step **510**, monitored wireless data traffic is inspected for the presence of abnormal events, e.g., excessive volume for the time of day, etc. Configurable thresholds for the monitored parameters may be dynamic over the course of the day and even for traffic for any given tower or base station. The configurable thresholds for monitored parameters may be stored in the Configurable Parameter Threshold database **310**.

As shown in step **520**, if one or more parameter thresholds are exceeded, a viral event may be triggered. In response, the Network Monitor **302** triggers the Crowd Risk Determinant **304** to perform a location-based push/pull service to determine the location of each trackable wireless device within a particular geographic area (e.g., communicating through given base stations or antennas).

When parameter thresholds are not surpassed, indicating that a viral event is not occurring, location data may be logged in the Historical Wireless Device Location Trends and Statistics database **312**, as depicted in step **530**. Location data logged in the Historical Wireless Device Location Trends and Statistics database **312** may be used by the Crowd Risk Determinant **304** for future analyses of crowd risk.

FIG. **3** depicts the flow of an exemplary Crowd Risk Determinant **304** of the Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, the Crowd Risk Determinant **304** performs a location-based push/pull service to obtain location information pertaining to trackable wireless devices in a given area regarding a respective viral event triggered by the Network Monitor **302**, as shown in step **540** of FIG. **3**.

In step **550**, collected location data is analyzed to assess the viral event that is occurring. The Crowd Risk Determinant **304** uses bounds and priorities set forth in the Risk Rules database **314** to determine if a possible viral event indicates a public safety risk. A viral pattern may or may not imply public safety risk. In step **560**, if a public safety risk is determined, the Crowd Risk Determinant **304** triggers the Alert Module **306** to take responsive public safety measures. Location data associated with a public safety risk is logged **530** in the Historical Wireless Device Location Trends and Statistics database **312**.

If the Crowd Risk Determinant **304** confirms that a particular viral event does not indicate a public safety risk, the Aggregate Location Dynometer (ALD) **400** is triggered to routinely log location data **530** in the Historical Wireless Device Location Trends and Statistics database **312** for potential future analyses.

Determination of a public safety risk in the Crowd Risk Determinant **304** triggers the Alert Module **306** to implement proper public safety response services. An Alert Module **306** is the final step in the risk determination process of the Aggregate Location Dynometer (ALD) **400**.

FIG. **4** depicts the flow of an exemplary Alert Module **306** of the Aggregate Location Dynometer (ALD) **400**, in accordance with the principles of the present invention.

In particular, as shown in step **700** of FIG. **4**, the Alert Module **306** is triggered by the Crowd Risk Determinant **304** and supplied the predetermined conditions constituting how to handle a determined public safety risk.

The Alert Module **306** immediately alerts the proper authorities **320** in the presence of a public safety risk, as depicted in step **710**.

Subsequent aggregate data collections may be made by the Alert Module **306** in step **720**. A particular public safety event may be programmed to result in multiple aggregate location data collections, set to occur at specific intervals. Moreover, a particular risk determination result may be configured to act as a triggered push/pull service **540** to acquire additional location data. Subsequent location information is routinely logged in the Historical Wireless Devices Location Trends and Statistics database **530**.

Configurable parameters are maintained in the Risk Rules database **314** to assist the Crowd Risk Determinant **304** in determining if location information pertaining to a viral event indicates a likely public safety risk. Factors for risk determination include but are not limited to the shape a cluster of location markers representing individual wireless devices of given density is forming, whether or not markers are spreading out or coming together, and/or at what rate of change a cluster of wireless devices is moving. Factors for risk determination also include the behavior of collective XY location coordinates of the most dense clusters of wireless devices, to where the most dense clusters of wireless devices of concern are moving, and/or whether or not a cluster of wireless devices in a particular location makes sense given the time of day.

For instance, empirical data may indicate that it is unusual for there to be a large number of wireless devices present downtown after business hours, or after a time when local bars and clubs have closed for the night. In this case, a configurable threshold may be set for a combination of location and time of day parameters (e.g., to articulate the number of wireless devices that must be present within a defined downtown region, after a given hour) to trigger a public safety risk. A configurable parameter threshold (e.g., specifying the number of wireless devices capable of inhabiting a particular geographic expanse or particular shape of device formation, or a given density within that region) may manually or empirically be set. If a parameter threshold is surpassed, the Crowd Risk Determinant **304** informs the Alert Module **306** of the development of a public safety risk.

The shape of a cluster of wireless devices may often offer significant clues to crowd risk potential. When location information is collected, the best-fit shape of dense clusters formed by accumulation of wireless devices in a given area may be determined. The best-fit shape of a cluster of wireless devices may be compared against data contained in the historical Acceptable/Non-Acceptable Crowd Shape database **308** to determine danger potential. Different thresholds may be set for like parameters based on varying location.

FIG. **5** denotes first exemplary Aggregate Location Dynometer (ALD) **400** location results, in accordance with the principles of the present invention.

In particular, the large oval shape **101** formed by markers representing individual wireless devices in the given geographical area **200** shown in FIG. **5**, may be interpreted as a group of individuals enjoying a sporting event in a stadium. Factors to consider are time of day and scheduled events. The example in FIG. **5** uses precise location.

FIG. **6** denotes second exemplary Aggregate Location Dynometer (ALD) **400** location results, in accordance with the principles of the present invention.

In particular, the pattern **102** in the geographical area **200** shown in FIG. **6** may be interpreted as cell sites pertaining to trackable individuals, assuming most individuals carry wireless devices. The same pattern may mean different things at different hours of the day. The exemplary location result shown in FIG. **6** uses coarse location.

FIG. **7** denotes third exemplary Aggregate Location Dynometer (ALD) **400** location results, in accordance with the principles of the present invention.

In particular, the crescent shape **103** in the geographical area **200** shown in FIG. **7** is recognized as a pattern to be wary of. This crescent shape may represent a variety of different occurrences (e.g., a protest in front of a given location such as a court house, a famous author at a bookstore, etc.). The exemplary location result shown in FIG. **7** uses precise location.

A rate-based parameter threshold may also or alternatively be set to define an acceptable rate at which wireless devices would otherwise normally inhabit a geographic area. For instance, if over a certain number of wireless devices enter an area in under a given amount of time (e.g., if three hundred wireless devices rush into a central pre-defined location in under ten minutes) then a public safety risk may be triggered.

Message content may be analyzed as an attribute for risk determination in response to a viral traffic event. For instance, a determination of the most frequent phrases may be matched against a database of suspected terms (e.g., "meet at the Lincoln Memorial", etc.).

Motion trends are also analyzed to assess crowd risk. The Crowd Risk Determinant **304** preferably determines whether the accumulation of wireless devices is becoming more or less dense about a central location and whether or not this behavior is expected based on trends and configured thresholds established for particular locations.

Precise accuracy of each individual device location is not extremely important in the present invention. Instead, focus lies in the volume, density, shape and movement of data points collected. Serving cell tower locations for each wireless device may be sufficient to satisfy initial triggering requirements for a possible viral event. The Aggregate Location Dynometer (ALD) **400** is concerned with aggregate location data as opposed to data involving individual device locations. Data regarding parameters such as special events, geographical boundaries, motion trends, density, clustering, spread, time of day and/or message content relating to trackable wireless devices are recorded in the Historical Wireless Device Location Trends and Statistics database **312**, as opposed to exact locations of specific wireless devices. Anonymity regarding precise locations of specific wireless devices alleviates some concern surrounding the privacy of individuals during location based services (LBS), as used within the present invention.

An Aggregate Location Dynometer (ALD) **400** has benefit to entities other than emergency management and crowd risk assessment parties. For instance, the present invention may also be used to estimate location trends in cities, to rank areas such as parks and beaches by volume of visitors, and even to peg traffic patterns. Historical crowd data need not represent a public safety issue, e.g., it may merely relate to city planning or disaster recovery. Thus, data collected while scanning for crowd risk provides cities, states and government with valuable information.

Though, preferably all wireless devices in a given area would be monitored for crowd gathering tendencies, it is also within the principles of the present invention to monitor only those devices by the relevant wireless carrier providing Location Dynometer (ALD) **400** services.

The present invention greatly benefits police, fire and general emergency response personnel **320** desiring early warning about possible crowd related risks, e.g., riots. Moreover,

the present invention is intended to combat nefarious cell technology to spawn mobs and riots without resorting to network restrictions.

While the invention makes use of the current location data of preferably all wireless devices within a given region, area, etc., the invention also preferably makes distinction between the current mode of operation of the wireless devices being analyzed for a possible public safety risk. For instance, analysis of the density, shape, movement, etc. in determining a possible public safety risk may analyze only wireless devices in active mode.

While the invention has been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments of the invention without departing from the true spirit and scope of the invention.

What is claimed is:

1. An aggregate location dynometer in a physical wireless network server, said aggregate location dynometer comprising:

a network monitor to monitor a wireless network for an indication of a potential viral event indicated by an aggregation of current locations of a plurality of physical wireless devices associated with said potential viral event; and

a crowd risk determinant to assess said aggregation of said current locations of said plurality of physical wireless devices pertaining to said potential viral event triggered by said network monitor.

2. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

an alert module to initiate an alert message relating to a public safety risk determined from said potential viral event.

3. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

an historical database maintaining a geographic region associated with said potential viral event.

4. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

an historical database maintaining a plurality of acceptable crowd shapes, a crowd shape being defined by a past aggregation of said current locations of said plurality of physical wireless devices associated with a known acceptable viral event.

5. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

an historical database maintaining a plurality of unacceptable crowd shapes, a crowd shape being defined by a past aggregation of said current locations of said plurality of physical wireless devices associated with a known unacceptable viral event.

6. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

a configurable parameter defining a threshold of a crowd shape becoming unacceptable and thus initiating said crowd risk.

7. The aggregate location dynometer in a physical wireless network server, said aggregate location dynometer according to claim **1**, further comprising:

an historical database maintaining a plurality of crowd shape trends based on historical locations of physical wireless devices during previous known viral events.

8. A method of alerting to a problematic crowd risk based on location based services (LBS), comprising:

monitoring wireless traffic for a potential impending viral event associated with a formation by an aggregation of current locations of a plurality of physical wireless devices within a given region;

requesting location information associated with said plurality of physical wireless devices; and

determining a crowd risk of said aggregation of said current locations of said plurality of physical wireless devices based on a crowd shape of said aggregation of said current locations of said plurality of physical wireless devices.

9. The method of alerting to a problematic crowd risk based on location based services (LBS) according to claim **8**, further comprising:

triggering a crowd alert message when said determined crowd risk is above a given threshold.

10. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **8**, wherein:

said crowd risk of said aggregation of said plurality of physical wireless devices is further determined based on a movement of said aggregation of said plurality of physical wireless devices.

11. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **10**, wherein said monitoring wireless traffic comprises:

monitoring wireless traffic at a given point in a wireless network; and

comparing a given traffic parameter associated with said aggregation of said current locations of said plurality of physical wireless devices, with an historical traffic parameter associated with a previous problematic crowd formation.

12. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **11**, wherein:

said given point is at a given base station in said wireless network.

13. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **10**, further comprising:

logging a snapshot formation created by said aggregation of said current locations of said plurality of physical wireless devices.

14. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **10**, further comprising:

initiating a location request for each of said plurality of physical wireless devices.

15. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **9**, further comprising:

comparing a viral pattern formed by said aggregation of said current locations of said plurality of wireless devices to predetermined risk rules.

16. The method of alerting to a problematic crowd risk with location based services (LBS) according to claim **15**, further comprising:

logging said viral pattern.

* * * * *

Exhibit C

to

Complaint
for Patent Infringement

Claim Charts[1] for the ’054 Patent

[1] Plaintiff provides these exemplary claim charts for the purposes of showing one basis of infringement of one of the Patents-in-suit by Defendant’s Accused Products as defined in the Complaint. These exemplary claim charts address the Accused Products broadly based on the fact that the Accused Products infringe in the same general way. Plaintiff reserves its right to amend and fully provide its infringement arguments and evidence thereof until its Preliminary and Final Infringement Contentions are later produced according to the court’s scheduling order in this case.

CLAIM CHART

U.S. PATENT NO. 9,198,054 B2 – CLAIM 1

Claim 1	Corresponding Structure in Accused Systems – Google LLC
[1a] An aggregate location dynometer in a physical wireless network server, said aggregate location dynometer comprising:	Google LLC ("Google") provides various services for alerting the public of emergencies through their Google Search and Google Maps services, known as Google Crisis Response. *See* https://crisisresponse.google/. Google Crisis Response together with various equipment, services, components, and/or software utilized in providing Google Crisis Response collectively include an aggregate location dynometer (ALD) as described by the meaning of this claim. Google Crisis Response is made available by a system owned and/or operated by Google. "Because infringement liability is not dependent on ownership, e.g., use of a system can infringe (35 U.S.C. § 271), infringement is not dependent on ownership of all limitations of a claim."
[1b] a network monitor to monitor a wireless network for an indication of a viral event;	Google Crisis Response includes alert services for various natural disasters and other emergencies including but not limited to floods, wildfires, earthquakes, and hurricanes. These services can utilize wireless networks to receive this information about viral events and continue to monitor for updated information. The following exemplifies this limitation's existence in Accused Systems: SOS Alerts on Google Search and Maps SOS Alerts on Search and Maps surface relevant and ongoing updates from official sources, including local authorities and emergency response organizations.

	Real-time flood forecasting Through partnerships with local governments, we've developed real-time flood forecasting models that predict when and where a flood might occur, along with its severity. **Improved visualizations** Using data from NOAA's satellites and the computing power of Google Earth Engine, we're able to detect an active wildfire and produce an approximate boundary on Google Search and Maps.

Detailed forecast cones

In the days leading up to a hurricane, detailed forecast cones from authoritative sources appear on Google Search and Maps that show the storm's predicted trajectory.

Timely navigation warnings

Within Google Maps you'll see a prominent alert if your route may be affected by storm activity—and we'll keep road conditions up to date so you can navigate safely.

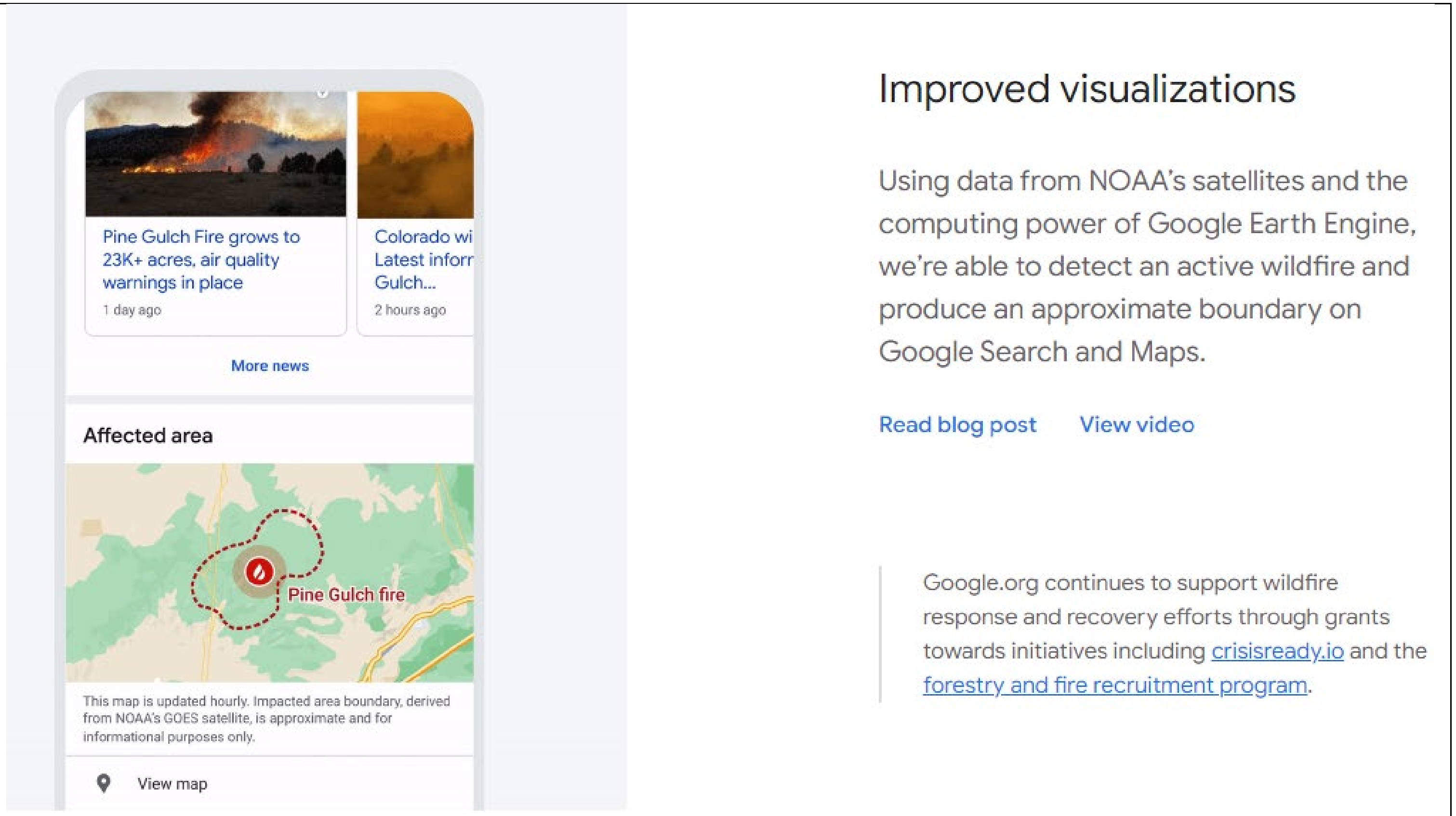
Source: (https://crisisresponse.google/forecasting-and-alerts/)

	Earthquakes happen daily around the world, with hundreds of millions of people living in earthquake prone regions. An early warning can help people prepare for shaking, but the public infrastructure to detect and alert everyone for an earthquake is costly to build and deploy. We saw an opportunity to use Android to provide people with timely, helpful earthquake information when they use Google search, and a few seconds warning to get themselves and their loved ones to safety if needed. Android Earthquake Alerts System is a free service that detects earthquakes around the world and can alert Android users before shaking starts. **Source:** (https://crisisresponse.google/android-alerts/)
[1c] a location aggregator to obtain a location of each of a plurality of wireless devices associated with said viral event;	Google Crisis Response includes alert services for various natural disasters and other emergencies including but not limited to floods, wildfires, earthquakes, and hurricanes. The Android Earthquake Alerts System uses location aggregation to detect earthquakes. The flood forecasting service can use location data to determine the wireless device's location relative to a predicted flood. The hurricane alert system can use location data to inform the user if their route may be impacted by a storm. The following exemplifies this limitation's existence in Accused Systems:

	Outside of these U.S. states, we use a crowdsourced approach to detect earthquakes. All smartphones contain tiny accelerometers that can sense vibrations and speed, signals that indicate an earthquake might be happening. If the phone detects something that it thinks may be an earthquake, it sends a signal to our earthquake detection server, along with a coarse location of where the shaking occurred. The server then combines information from many phones to figure out if an earthquake is happening. This approach uses the 2+billion Android phones in use around the world as mini-seismometers to create the world's largest earthquake detection network; the phones detect the vibration and speed of shaking of an earthquake, and alert Android users in affected areas accordingly. **Source:** (https://crisisresponse.google/android-alerts/) SOS notifications from Google When you're in a location affected by a disaster, you may receive a notification from the Google app directing you to an SOS Alert on Search where you'll access credible safety information.

	Interactive maps People can quickly access an interactive map where they can see their location relative to the predicted flood. Timely navigation warnings Within Google Maps you'll see a prominent alert if your route may be affected by storm activity—and we'll keep road conditions up to date so you can navigate safely. 

	Source: (https://crisisresponse.google/forecasting-and-alerts/)
[1d] a crowd risk determinant, triggered by said network monitor, to determine a crowd risk based on an aggregation of said location of each of said plurality of wireless devices associated with said viral event; and	Google Crisis Response includes alert services for various natural disasters and other emergencies including but not limited to floods, wildfires, earthquakes, and hurricanes. The wildfire alert system can determine an approximate boundary of an active wildfire using satellite data. The Android Earthquake Alerts System uses information from many phones to determine whether an earthquake is occurring and determines risk level with the Modified Mercalli Intensity (MMI) scale. The flood forecasting service uses a model to predict what areas will be flooded and how deep the water may be. *See* https://ai.googleblog.com/2020/09/the-technology-behind-our-recent.html. The following exemplifies this limitation's existence in Accused Systems:



Source: (https://crisisresponse.google/forecasting-and-alerts/)

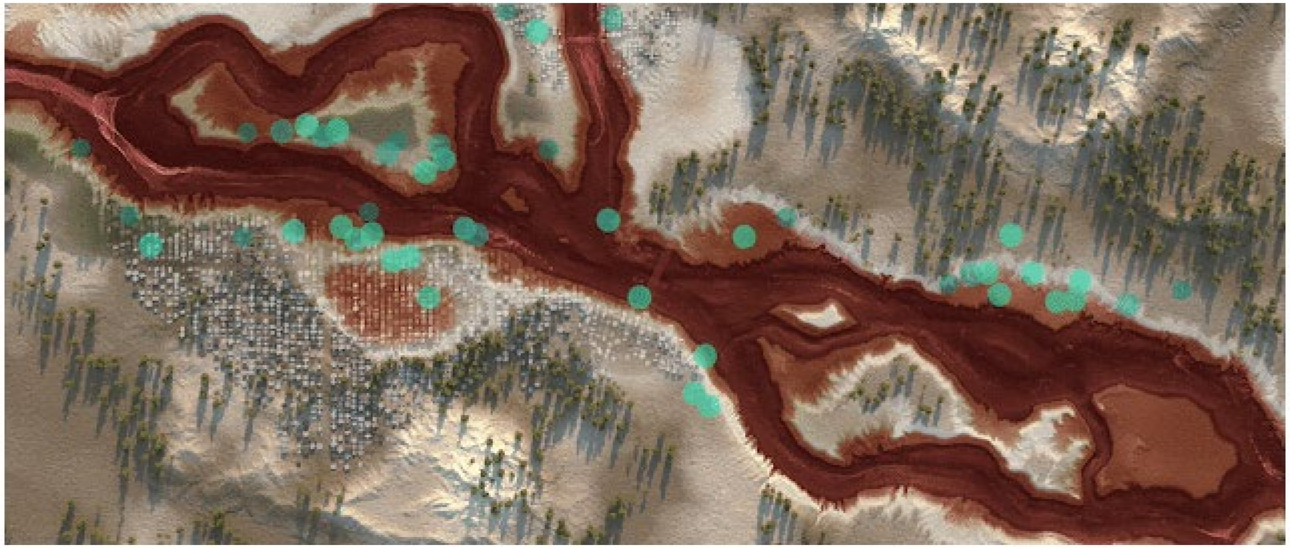
	All smartphones come with tiny accelerometers that can sense signals that indicate an earthquake might be happening. If the phone detects something that it thinks may be an earthquake, it sends a signal to our earthquake detection server, along with a coarse location of where the shaking occurred. The server then combines information from many phones to figure out if an earthquake is happening. We're essentially racing the speed of light (which is roughly the speed at which signals from a phone travel) against the speed of an earthquake. And lucky for us, the speed of light is much faster! **Source:** (https://blog.google/products/android/earthquake-detection-and-alerts/) **Be Aware Alert** • Designed to give you a heads up for light shaking, and provide more information when you tap on the notification. • Only sent to users who will experience MMI 3 & 4 shaking during an earthquake of magnitude 4.5 or greater • Respects the Volume, Do Not Disturb and Notification settings on your device. **Take Action Alert** • Designed to get your attention before you experience moderate to heavy shaking, so that you can take action to protect yourself. • Only sent to users who will experience MMI 5+ shaking during an earthquake of magnitude 4.5 or greater. • Will break through Do Not Disturb settings, turn on your screen and play a loud sound.

Source: (https://crisisresponse.google/android-alerts/)

This year, we've launched a new forecasting model that will allow us to double the lead time of many of our alerts—providing more notice to governments and giving tens of millions of people an extra day or so to prepare.

We're providing people with information about flood depth: when and how much flood waters are likely to rise. And in areas where we can produce depth maps throughout the floodplain, we're sharing information about depth in the user's village or area.

Source: (https://blog.google/technology/ai/flood-forecasts-india-bangladesh/)

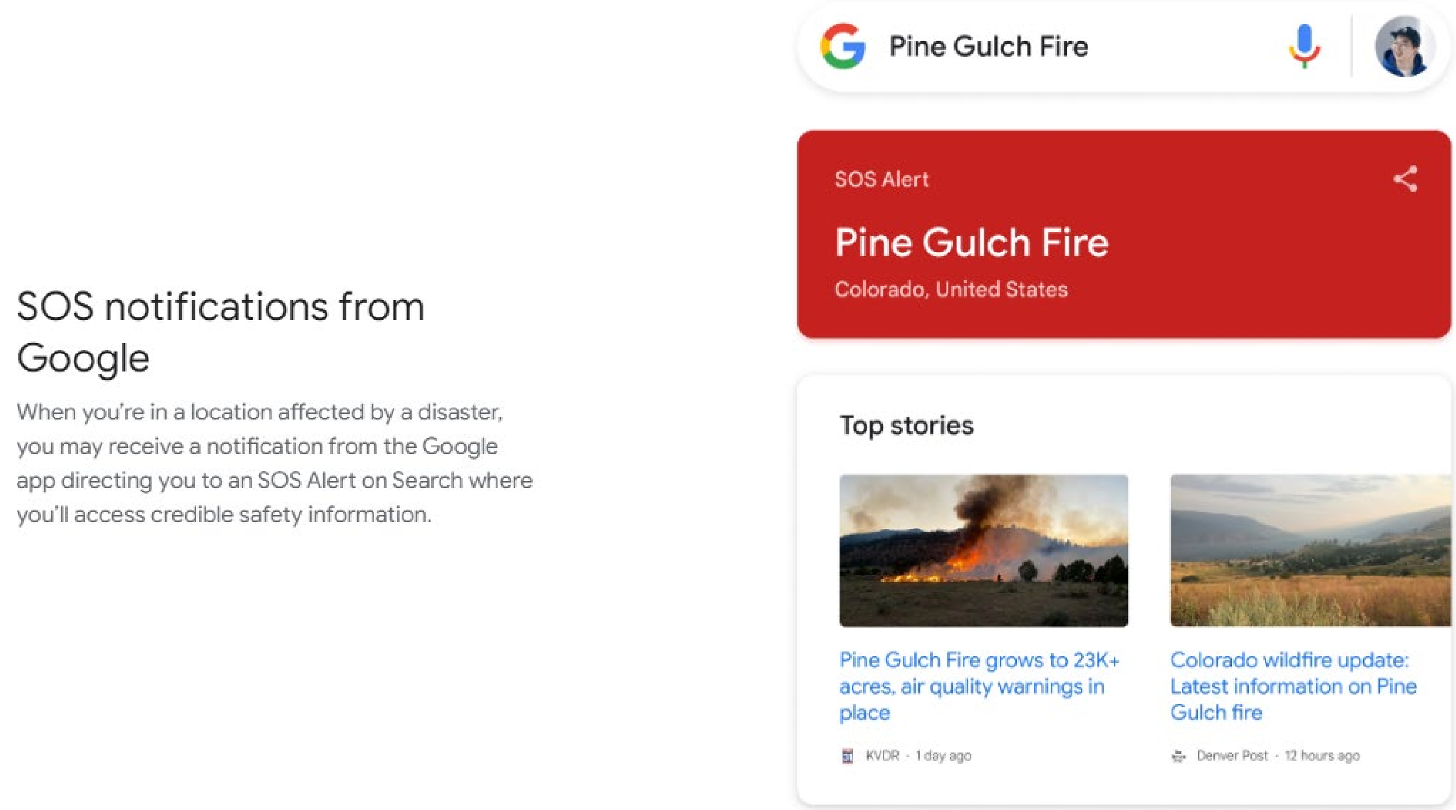


Inundation modeling estimates what areas will be flooded and how deep the water will be. This visualization conceptually shows how inundation could be simulated, how risk levels could be defined (represented by red and white colors), and how the model could be used to identify areas that should be warned (green dots).

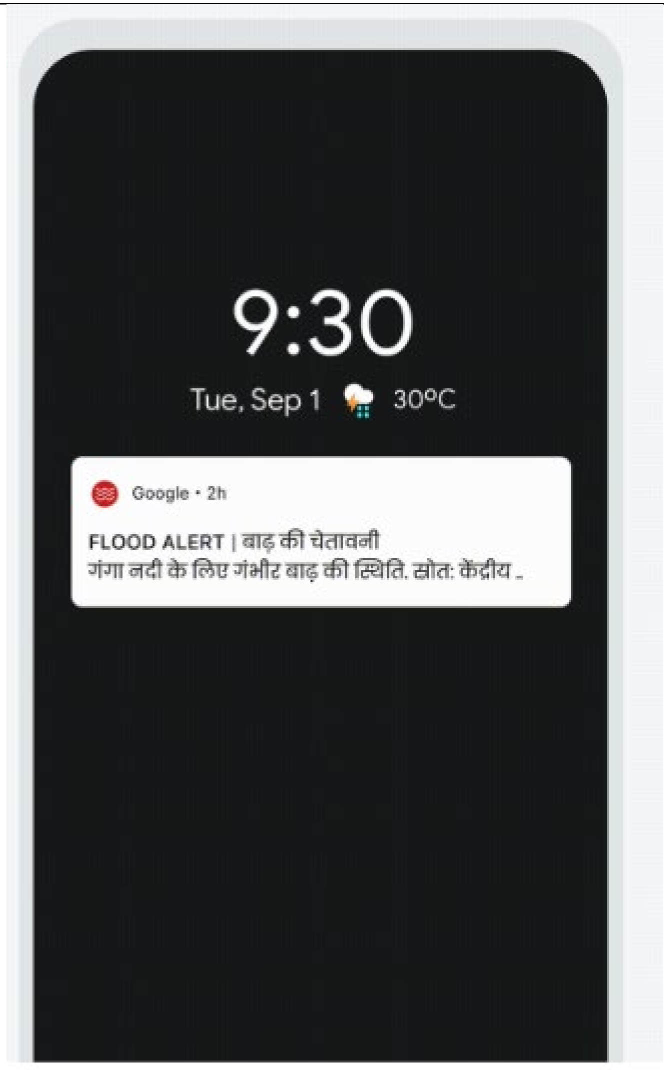
Source: (https://ai.googleblog.com/2020/09/the-technology-behind-our-recent.html)

<table>
<tr>
<td>[1e] an alert module to initiate an alert message relating to a public safety risk determined from an analysis of said viral event.</td>
<td>
Google Crisis Response includes alert services for various natural disasters and other emergencies including but not limited to floods, wildfires, earthquakes, and hurricanes. Once an emergency has been identified by the location aggregator and risk determinant, the wireless devices can display the alert notifications.

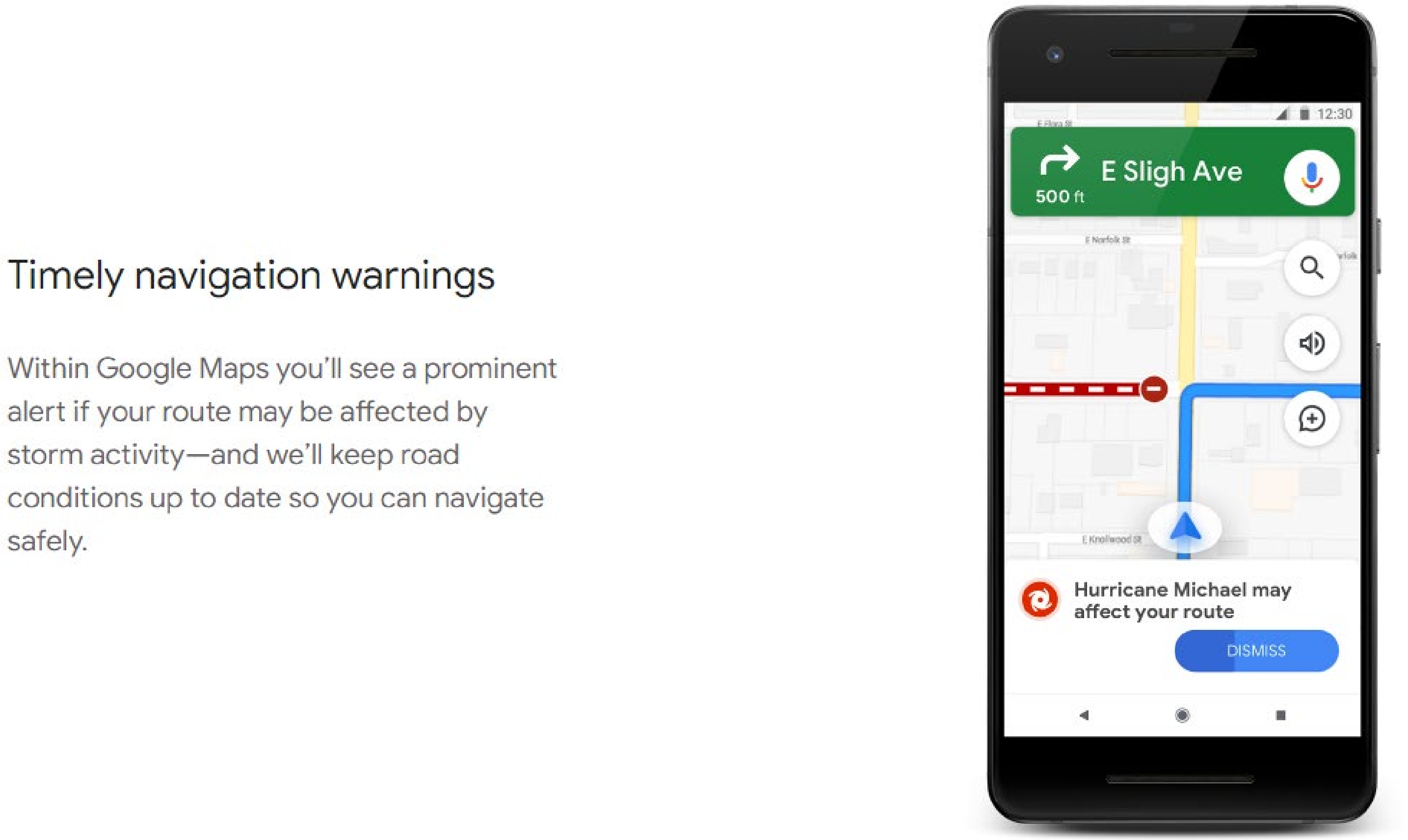
The following exemplifies this limitation's existence in Accused Systems:



</td>
</tr>
</table>

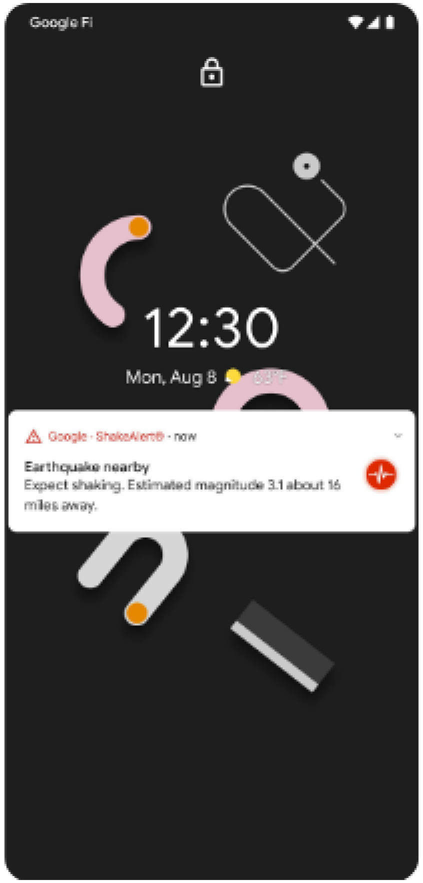
	

9:30
Tue, Sep 1 30°C
Google • 2h
FLOOD ALERT \| बाढ़ की चेतावनी
गंगा नदी के लिए गंभीर बाढ़ की स्थिति. स्रोत: केंद्रीय ..

	 **Source:** (https://crisisresponse.google/forecasting-and-alerts/)

Alerting Users During an Earthquake

Android has two types of notifications designed to alert users about an earthquake. Both alert types are only sent for earthquakes of magnitude 4.5 or greater.



Be Aware Alert
[Weak / Light Shaking]

Take Action Alert
[Moderate / Extreme Shaking]

	Source: (https://crisisresponse.google/android-alerts/)

CLAIM CHART

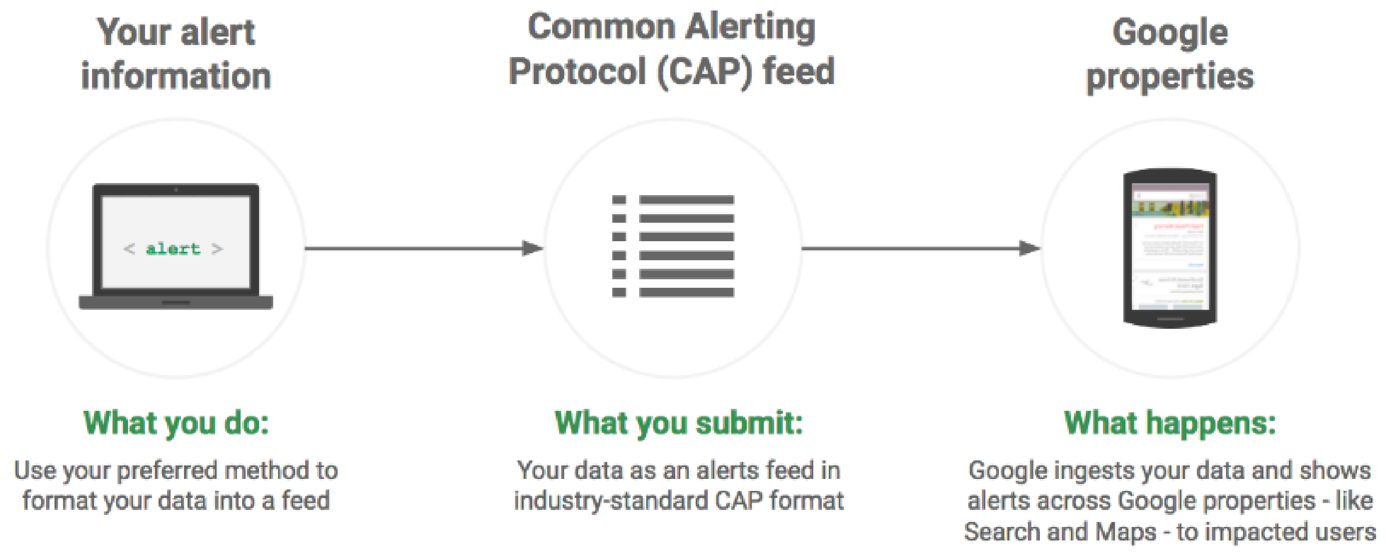
U.S. PATENT NO. 9,198,054 B2 – CLAIM 1

Claim 1	Corresponding Structure in Accused Systems – Google LLC
[1a] An aggregate location dynometer in a physical wireless network server, said aggregate location dynometer comprising:	Google LLC ("Google") provides a service for alerting the public of emergencies through their Google Search, Google Maps, and Google Now services, known as the Google Public Alerts platform. *See* https://support.google.com/publicalerts/ and https://developers.google.com/public-alerts. The Google Public Alerts platform together with various equipment, services, components, and/or software utilized in providing the Google Public Alerts platform collectively include an aggregate location dynometer (ALD) as described by the meaning of this claim. The Google Public Alerts platform is made available by a system owned and/or operated by Google. The system has been migrated to be part of the Google Search and Google Maps services. What's happening with the Google Public Alerts website? Google is migrating and upgrading Public Alerts (PA) to the more accessible, modern Google Search and Google Maps experience. As an important step to improve the user experience, the Google.org Public Alerts website will be unavailable after March 31, 2021. To view details of alerts and their associated rich visualization, Google Public Alerts partners and users can now directly search on Google Search and Google Maps. For example, when you search for information on active wildfires, tropical storms, floods, and earthquakes, you can find relevant and authoritative content in our SOS Alerts and Public Alerts. These alerts include emergency phone numbers and websites, maps, translations of useful phrases, and donation opportunities. For a complete overview of Google's crisis-related products and features, go to the Google Crisis Response website . **Source:** (https://support.google.com/publicalerts/) Google Now has been succeeded by Google Feed and Google Assistant. *See* https://en.wikipedia.org/wiki/Google_Now.

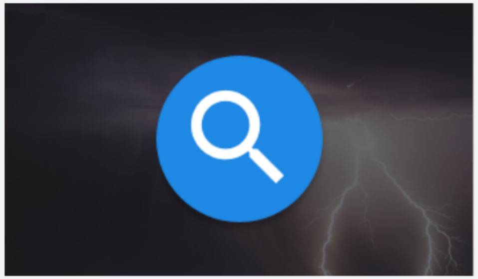
	"Because infringement liability is not dependent on ownership, e.g., use of a system can infringe (35 U.S.C. § 271), infringement is not dependent on ownership of all limitations of a claim."
[1b] a network monitor to monitor a wireless network for an indication of a viral event;	The Google Public Alerts platform monitors alert data from a wireless network of authorized alert originators and distributors and can transmit the data to wireless mobile devices through wireless networks. The user can also discover the information through manual use of Google Search and Google Maps. The following exemplifies this limitation's existence in Accused Systems:

How Google Public Alerts work

1. Partners format their data in the industry standard Common Alerting Protocol (CAP) format.
2. Partners transmit the CAP formatted data in a feed.
3. Google ingests the data and publishes it. Note that since the data format is an industry standard, it can be provided to any downstream consumer that supports the Common Alerting Protocol.



Source: (https://developers.google.com/public-alerts/guides/introduction)

	   Results in Google Search If you search for a place where there is a relevant active alert, or from within an affected area where there's a relevant active alert, you'll see a warning, and a link to click through to find out more information. Local updates on Google Maps If you're searching Maps on desktop or mobile, you'll get relevant alerts for that area. The Google Maps for Mobile app can also display a warning notification if there is a relevant alert nearby. Notifications on Google Now If there's a relevant active alert for your local area, you'll receive a notification to let you know what's going on, and where. **Source:** (https://developers.google.com/public-alerts)
[1c] a location aggregator to obtain a location of each of a plurality of wireless devices associated with said viral event;	The Google Public Alerts platform can determine the locations of wireless devices using location data. The platform can use location aggregation of a plurality of wireless devices to determine the area affected by the viral event. The following exemplifies this limitation's existence in Accused Systems:

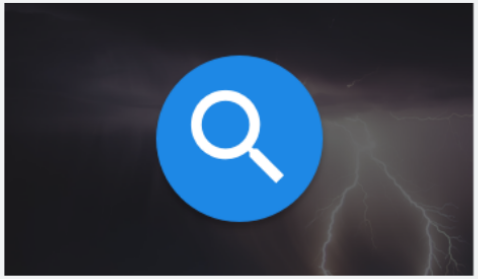
How is Google Public Alerts integrated with Google Now on Android?

Public alert information fits well with Google Now's goals of showing you the information that matters where you are.

A Public Alerts card will show when there is an important emergency alert in your area, as published by authoritative sources such as the National Weather Service, and the US Geological Survey (USGS). The alert will automatically show as the first card in Android's Google Now service when swiping up on your Android device. The title and publisher of the alert will be displayed on the card as well as a brief snippet of text about the alert. If you would like to learn more about the alert, including alert location, click on the "More Info" link and you will be taken to the alert details page.

You will only see alerts if they have been published for your location by authoritative sources. Google will only show the most severe alerts in Google Now, similar to the level that triggers most national emergency alert systems. If there are no alerts for your area, no Public Alerts cards will be displayed. Public Alerts will also show up in your notification shade when updates are available -- just swipe down from the top of your screen to open or dismiss these notifications.

Source: (https://support.google.com/publicalerts/)



Results in Google Search

If you search for a place where there is a relevant active alert, or from within an affected area where there's a relevant active alert, you'll see a warning, and a link to click through to find out more information.

Local updates on Google Maps

If you're searching Maps on desktop or mobile, you'll get relevant alerts for that area. The Google Maps for Mobile app can also display a warning notification if there is a relevant alert nearby.

Notifications on Google Now

If there's a relevant active alert for your local area, you'll receive a notification to let you know what's going on, and where.

	Source: (https://developers.google.com/public-alerts) Google Search Desktop and mobile searches trigger alerts when and where they are relevant for our users. The alerts information that you provide defines the area affected by an emergency or warning condition, and the severity of the event. Along with this information, factors that determine who will see the alert include the user's query and the location of the user's device. For example, a user who is outside the affected area described in the CAP data may need to enter a more detailed search query to see the alert than a user who is inside the affected area. The alert results in a warning that the user can click through to find out more information. Google Maps Google Maps displays geographic data to users on computers, tablets, and mobile phones. When searching an area in Maps on a desktop or a mobile app, nearby relevant alerts for that area appear. The mobile app also provides location based warning notifications for relevant alerts. Google Now Google Now provides active relevant alert notifications based on the device location. Notifications include a description of what's going on, the affected area, and possible actions to take in order to stay safe. **Source:** (https://developers.google.com/public-alerts/guides/introduction)

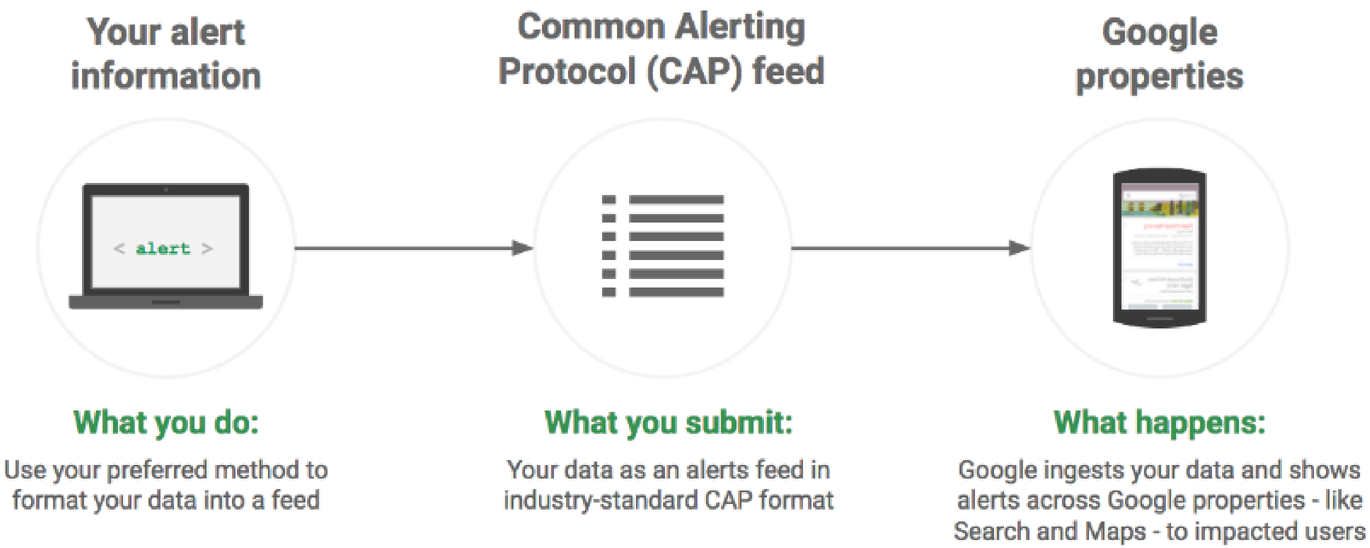
[1d] a crowd risk determinant, triggered by said network monitor, to determine a crowd risk based on an aggregation of said location of each of said plurality of wireless devices associated with said viral event; and	The Google Public Alerts platform can alert wireless mobile devices of a viral event within a particular geographical area when the devices within that particular geographical area receive an alert associated with said viral event by monitoring Google's public alert data through a wireless network. Using data from authorized alert originators and distributors for each particular geographical area, risk can be determined. For a list of partners, see https://support.google.com/publicalerts/#3249690. The following exemplifies this limitation's existence in Accused Systems: **How does Google work with government agencies like the US National Weather Service?** Google partners with authorized alert originators and distributors listed here. For additional information about preparing Public Alerts data, please visit our Partner Help Center.

	I'm from a public agency and I'd love to see our alerts on Google Public Alerts. How do I make that happen? We welcome partnerships with agencies, domestic and international, who publish authoritative alerts. In order to get a head start, you can follow the steps below: • Get your alerts into the Common Alerting Protocol (CAP 1.2) standard. Here are some resources we created to help you with this process. Most commercial alert publishing tools support CAP already. • Validate that you've set-up your feeds correctly and that your CAP is correct. After performing the steps above please fill out this contact form. If Google is interested in integrating your data into public alerts, we will respond to your initial inquiry submitted through this form and schedule a call to talk with your organization. The purpose of the call is to allow us to better understand what content you are interested in bringing to Public Alerts. If we want to move forward with your organization and your data, we will proceed to a data evaluation stage. During this stage, we may request that you provide us with sample data, technical support from your team, and further information about your systems and process. In parallel, we will work with you on an agreement to disseminate your data. Once we evaluate your data, and if we determine that your data is a match for Public Alerts, we will continue to work with your team to integrate your data into Public Alerts. **Source:** (https://support.google.com/publicalerts/)

	Who can publish Google Public Alerts Partners who publish a Google Public Alert must be: • a public safety agency or a public alerts provider with information that affects people's life and property, and • the original and authoritative author of the alert information OR have rights from the original author to aggregate and/or distribute this information. All meteorological agencies should register with the WMO register of alerting authorities. In the U.S., we also prefer for our partners to be a certified IPAWS Public Alerting Authority.

How Google Public Alerts work

1. Partners format their data in the industry standard Common Alerting Protocol (CAP) format.
2. Partners transmit the CAP formatted data in a feed.
3. Google ingests the data and publishes it. Note that since the data format is an industry standard, it can be provided to any downstream consumer that supports the Common Alerting Protocol.



Source: (https://developers.google.com/public-alerts/guides/introduction)

[1e] an alert module to initiate an alert message relating to a public safety risk determined from an analysis of said viral event.	The Google Public Alerts platform can send alert messages to devices through the Google Now service. Authorized alert originators and distributors can initiate alert messages relating to a public safety risk through the Google Public Alerts platform. The alerts are displayed on the wireless mobile devices through Google Now once received. The alerts can also be shown through Google Search and Google Maps. The following exemplifies this limitation's existence in Accused Systems: **How is Google Public Alerts integrated with Google Now on Android?** Public alert information fits well with Google Now's goals of showing you the information that matters where you are. A Public Alerts card will show when there is an important emergency alert in your area, as published by authoritative sources such as the National Weather Service, and the US Geological Survey (USGS). The alert will automatically show as the first card in Android's Google Now service when swiping up on your Android device. The title and publisher of the alert will be displayed on the card as well as a brief snippet of text about the alert. If you would like to learn more about the alert, including alert location, click on the "More Info" link and you will be taken to the alert details page. You will only see alerts if they have been published for your location by authoritative sources. Google will only show the most severe alerts in Google Now, similar to the level that triggers most national emergency alert systems. If there are no alerts for your area, no Public Alerts cards will be displayed. Public Alerts will also show up in your notification shade when updates are available -- just swipe down from the top of your screen to open or dismiss these notifications. **What kinds of alerts show on Google Now on Android?** Google Now strives to show the most severe and relevant emergency alerts from the same providers we use for Public Alerts in other Google products. We will only attempt to display an alert if it is published in the language of your device.

	Can I see Public Alerts on Google Maps with my mobile browser? Yes. If you go to your mobile browser and head to Google Maps at maps.google.com, we will show you relevant weather, public safety and earthquake alerts when they are triggered by your search. The alerts will show up at the top of the screen when viewing the business listings for your search. If you want to learn more you can click "more details" and it will take you to an alert details page similar to the experience on Google Maps on your desktop. **How is Google Public Alerts integrated with Google Maps for Mobile?** When searching on Google Maps for Mobile on your Android device, if the corresponding location of your search triggers a relevant alert, the alert will be displayed at the top of search results in an orange banner. If you would like to dismiss the alert you can click on it and select **hide alert**. If you want to view more details, click on it and select **view more details**. This will lead you to an alert details page where you can learn more about the alert. Please note that at this time no public alerts will ever appear when using the directions feature. While we can't guarantee that you'll see every alert when searching on Google Maps for Mobile, we're doing our best to show what's important when you need it, and hope that Google Public Alerts is a useful additional source of information. **Source:** (https://support.google.com/publicalerts/)

	 Results in Google Search If you search for a place where there is a relevant active alert, or from within an affected area where there's a relevant active alert, you'll see a warning, and a link to click through to find out more information. Local updates on Google Maps If you're searching Maps on desktop or mobile, you'll get relevant alerts for that area. The Google Maps for Mobile app can also display a warning notification if there is a relevant alert nearby. Notifications on Google Now If there's a relevant active alert for your local area, you'll receive a notification to let you know what's going on, and where. **Source:** (https://developers.google.com/public-alerts)

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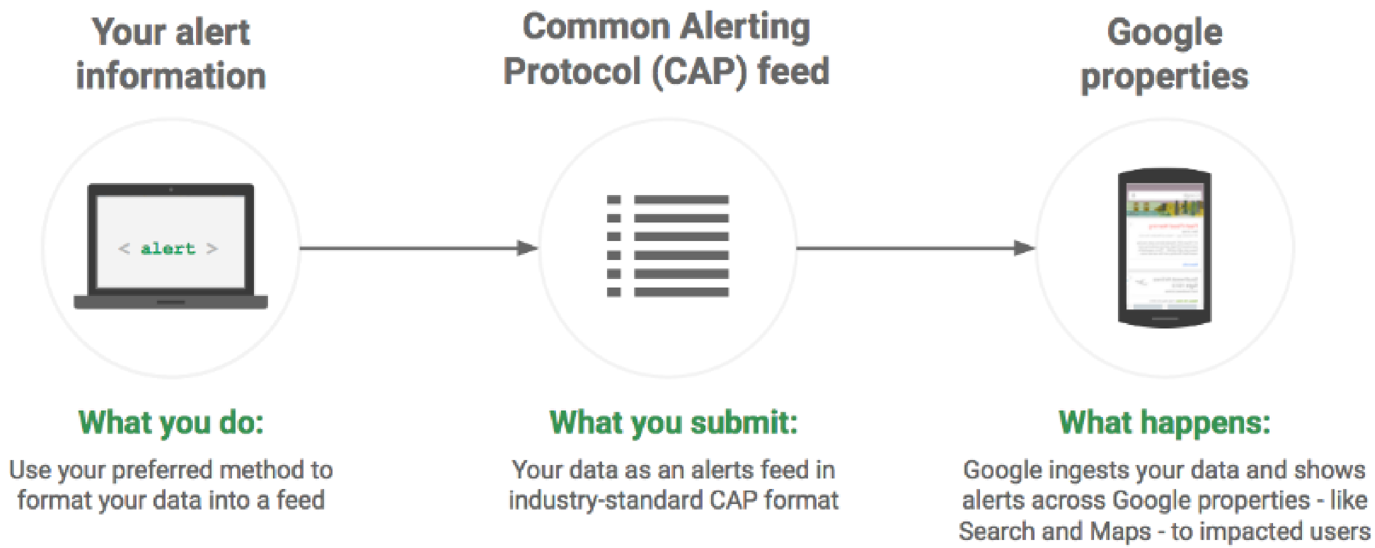

Source: (https://developers.google.com/public-alerts/guides/introduction)

Exhibit D

to

Complaint
for Patent Infringement

Claim Charts[1] for the ’158 Patent

[1] Plaintiff provides these exemplary claim charts for the purposes of showing one basis of infringement of one of the Patents-in-suit by Defendant’s Accused Products as defined in the Complaint. These exemplary claim charts addresses the Accused Products broadly based on the fact that the Accused Products infringe in the same general way. Plaintiff reserves its right to amend and fully provide its infringement arguments and evidence thereof until its Preliminary and Final Infringement Contentions are later produced according to the court’s scheduling order in this case.

CLAIM CHART

U.S. PATENT NO. 9,402,158 B2 – CLAIM 1

Claim 1	Corresponding Structure in Accused Systems – Google LLC
[1a] An aggregate location dynometer in a physical wireless network server, said aggregate location dynometer comprising:	Google LLC ("Google") provides various services for alerting the public of emergencies through their Google Search and Google Maps services, known as Google Crisis Response. *See* https://crisisresponse.google/. Google Crisis Response together with various equipment, services, components, and/or software utilized in providing Google Crisis Response collectively include an aggregate location dynometer (ALD) as described by the meaning of this claim. Google Crisis Response is made available by a system owned and/or operated by Google. "Because infringement liability is not dependent on ownership, e.g., use of a system can infringe (35 U.S.C. § 271), infringement is not dependent on ownership of all limitations of a claim."
[1b] a network monitor to monitor a wireless network for an indication of a potential viral event indicated by an aggregation of current locations of a plurality of physical wireless devices associated with said potential viral event; and	Google Crisis Response includes alert services for various natural disasters and other emergencies including but not limited to floods, wildfires, earthquakes, and hurricanes. These services can utilize wireless networks to receive this information about viral events and continue to monitor for updated information. The Android Earthquake Alerts System uses location aggregation to detect earthquakes. The flood forecasting service can use location data to determine the wireless device's location relative to a predicted flood. The hurricane alert system can use location data to inform the user if their route may be impacted by a storm. The following exemplifies this limitation's existence in Accused Systems: SOS Alerts on Google Search and Maps SOS Alerts on Search and Maps surface relevant and ongoing updates from official sources, including local authorities and emergency response organizations.

Real-time flood forecasting

Through partnerships with local governments, we've developed real-time flood forecasting models that predict when and where a flood might occur, along with its severity.

Improved visualizations

Using data from NOAA's satellites and the computing power of Google Earth Engine, we're able to detect an active wildfire and produce an approximate boundary on Google Search and Maps.

	Detailed forecast cones In the days leading up to a hurricane, detailed forecast cones from authoritative sources appear on Google Search and Maps that show the storm's predicted trajectory. **Source:** (https://crisisresponse.google/forecasting-and-alerts/) Earthquakes happen daily around the world, with hundreds of millions of people living in earthquake prone regions. An early warning can help people prepare for shaking, but the public infrastructure to detect and alert everyone for an earthquake is costly to build and deploy. We saw an opportunity to use Android to provide people with timely, helpful earthquake information when they use Google search, and a few seconds warning to get themselves and their loved ones to safety if needed. Android Earthquake Alerts System is a free service that detects earthquakes around the world and can alert Android users before shaking starts.

	Outside of these U.S. states, we use a crowdsourced approach to detect earthquakes. All smartphones contain tiny accelerometers that can sense vibrations and speed, signals that indicate an earthquake might be happening. If the phone detects something that it thinks may be an earthquake, it sends a signal to our earthquake detection server, along with a coarse location of where the shaking occurred. The server then combines information from many phones to figure out if an earthquake is happening. This approach uses the 2+billion Android phones in use around the world as mini-seismometers to create the world's largest earthquake detection network; the phones detect the vibration and speed of shaking of an earthquake, and alert Android users in affected areas accordingly. **Source:** (https://crisisresponse.google/android-alerts/) SOS notifications from Google When you're in a location affected by a disaster, you may receive a notification from the Google app directing you to an SOS Alert on Search where you'll access credible safety information.

	Interactive maps People can quickly access an interactive map where they can see their location relative to the predicted flood. Timely navigation warnings Within Google Maps you'll see a prominent alert if your route may be affected by storm activity—and we'll keep road conditions up to date so you can navigate safely. 

	Source: (https://crisisresponse.google/forecasting-and-alerts/)
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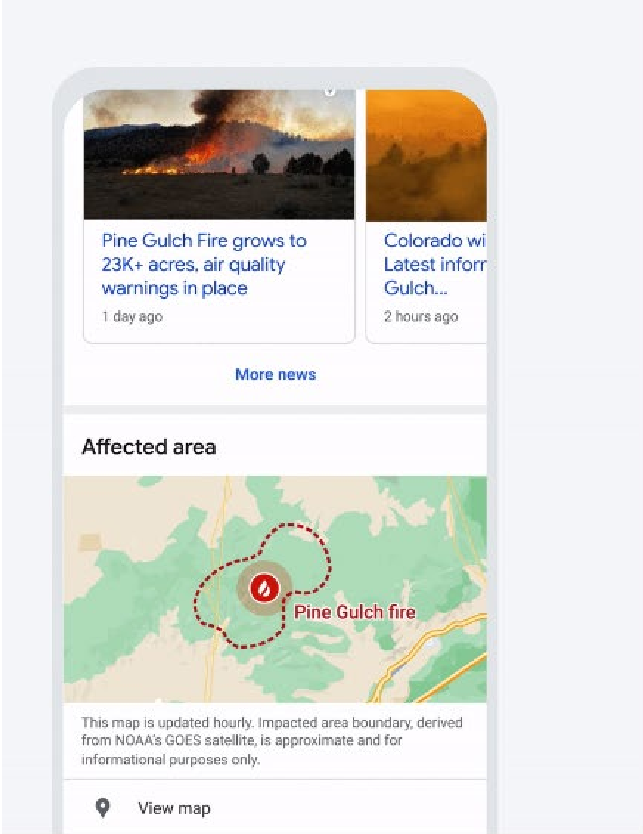


Improved visualizations

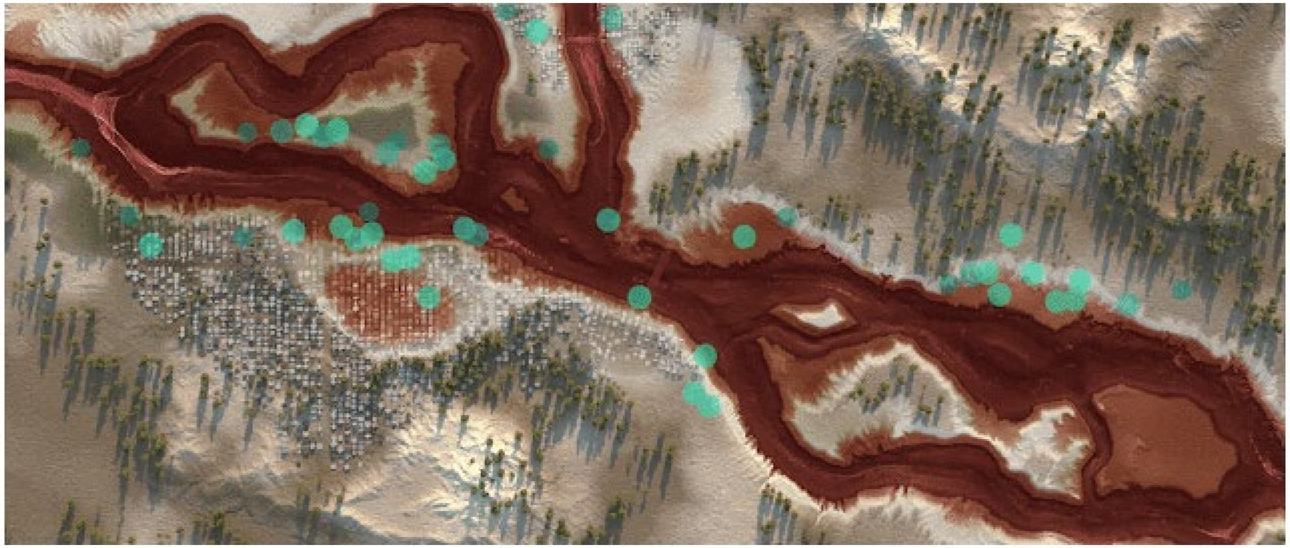
Using data from NOAA's satellites and the computing power of Google Earth Engine, we're able to detect an active wildfire and produce an approximate boundary on Google Search and Maps.

Read blog post View video

> Google.org continues to support wildfire response and recovery efforts through grants towards initiatives including crisisready.io and the forestry and fire recruitment program.

Source: (https://crisisresponse.google/forecasting-and-alerts/)

	All smartphones come with tiny accelerometers that can sense signals that indicate an earthquake might be happening. If the phone detects something that it thinks may be an earthquake, it sends a signal to our earthquake detection server, along with a coarse location of where the shaking occurred. The server then combines information from many phones to figure out if an earthquake is happening. We're essentially racing the speed of light (which is roughly the speed at which signals from a phone travel) against the speed of an earthquake. And lucky for us, the speed of light is much faster! **Source:** (https://blog.google/products/android/earthquake-detection-and-alerts/) **Be Aware Alert** • Designed to give you a heads up for light shaking, and provide more information when you tap on the notification. • Only sent to users who will experience MMI 3 & 4 shaking during an earthquake of magnitude 4.5 or greater • Respects the Volume, Do Not Disturb and Notification settings on your device. **Take Action Alert** • Designed to get your attention before you experience moderate to heavy shaking, so that you can take action to protect yourself. • Only sent to users who will experience MMI 5+ shaking during an earthquake of magnitude 4.5 or greater. • Will break through Do Not Disturb settings, turn on your screen and play a loud sound.

	Source: (https://crisisresponse.google/android-alerts/) This year, we've launched a new forecasting model that will allow us to double the lead time of many of our alerts—providing more notice to governments and giving tens of millions of people an extra day or so to prepare. We're providing people with information about flood depth: when and how much flood waters are likely to rise. And in areas where we can produce depth maps throughout the floodplain, we're sharing information about depth in the user's village or area. **Source:** (https://blog.google/technology/ai/flood-forecasts-india-bangladesh/)  Inundation modeling estimates what areas will be flooded and how deep the water will be. This visualization conceptually shows how inundation could be simulated, how risk levels could be defined (represented by red and white colors), and how the model could be used to identify areas that should be warned (green dots). **Source:** (https://ai.googleblog.com/2020/09/the-technology-behind-our-recent.html)

CLAIM CHART

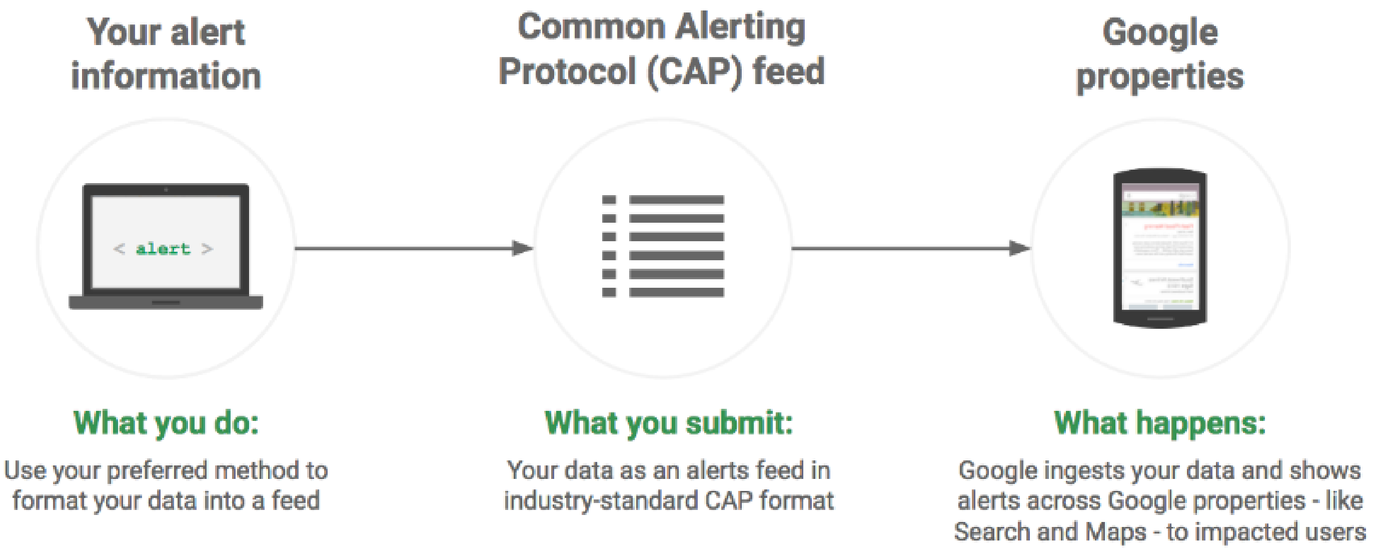
U.S. PATENT NO. 9,402,158 B2 – CLAIM 1

Claim 1	Corresponding Structure in Accused Systems – Google LLC
[1a] An aggregate location dynometer in a physical wireless network server, said aggregate location dynometer comprising:	Google LLC ("Google") provides a service for alerting the public of emergencies through their Google Search, Google Maps, and Google Now services, known as the Google Public Alerts platform. *See* https://support.google.com/publicalerts/ and https://developers.google.com/public-alerts. The Google Public Alerts platform together with various equipment, services, components, and/or software utilized in providing the Google Public Alerts platform collectively include an aggregate location dynometer (ALD) as described by the meaning of this claim. The Google Public Alerts platform is made available by a system owned and/or operated by Google. The system has been migrated to be part of the Google Search and Google Maps services. **What's happening with the Google Public Alerts website?** Google is migrating and upgrading Public Alerts (PA) to the more accessible, modern Google Search and Google Maps experience. As an important step to improve the user experience, the Google.org Public Alerts website will be unavailable after March 31, 2021. To view details of alerts and their associated rich visualization, Google Public Alerts partners and users can now directly search on Google Search and Google Maps. For example, when you search for information on active wildfires, tropical storms, floods, and earthquakes, you can find relevant and authoritative content in our SOS Alerts and Public Alerts. These alerts include emergency phone numbers and websites, maps, translations of useful phrases, and donation opportunities. For a complete overview of Google's crisis-related products and features, go to the Google Crisis Response website . **Source:** (https://support.google.com/publicalerts/) Google Now has been succeeded by Google Feed and Google Assistant. *See* https://en.wikipedia.org/wiki/Google_Now.

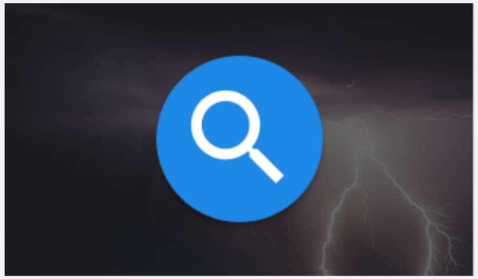
	"Because infringement liability is not dependent on ownership, e.g., use of a system can infringe (35 U.S.C. § 271), infringement is not dependent on ownership of all limitations of a claim."
[1b] a network monitor to monitor a wireless network for an indication of a potential viral event indicated by an aggregation of current locations of a plurality of physical wireless devices associated with said potential viral event; and	The Google Public Alerts platform monitors alert data from a wireless network of authorized alert originators and distributors and can transmit the data to wireless mobile devices through wireless networks. The user can also discover the information through manual use of Google Search and Google Maps. The Google Public Alerts platform additionally can determine the locations of wireless devices using location data. The platform can use location aggregation of a plurality of wireless devices to determine the area affected by the viral event. The following exemplifies this limitation's existence in Accused Systems:

How Google Public Alerts work

1. Partners format their data in the industry standard Common Alerting Protocol (CAP) format.
2. Partners transmit the CAP formatted data in a feed.
3. Google ingests the data and publishes it. Note that since the data format is an industry standard, it can be provided to any downstream consumer that supports the Common Alerting Protocol.



Source: (https://developers.google.com/public-alerts/guides/introduction)

	 Results in Google Search If you search for a place where there is a relevant active alert, or from within an affected area where there's a relevant active alert, you'll see a warning, and a link to click through to find out more information.  Local updates on Google Maps If you're searching Maps on desktop or mobile, you'll get relevant alerts for that area. The Google Maps for Mobile app can also display a warning notification if there is a relevant alert nearby.  Notifications on Google Now If there's a relevant active alert for your local area, you'll receive a notification to let you know what's going on, and where. **Source:** (https://developers.google.com/public-alerts) **How is Google Public Alerts integrated with Google Now on Android?** Public alert information fits well with Google Now's goals of showing you the information that matters where you are. A Public Alerts card will show when there is an important emergency alert in your area, as published by authoritative sources such as the National Weather Service, and the US Geological Survey (USGS). The alert will automatically show as the first card in Android's Google Now service when swiping up on your Android device. The title and publisher of the alert will be displayed on the card as well as a brief snippet of text about the alert. If you would like to learn more about the alert, including alert location, click on the "More Info" link and you will be taken to the alert details page. You will only see alerts if they have been published for your location by authoritative sources. Google will only show the most severe alerts in Google Now, similar to the level that triggers most national emergency alert systems. If there are no alerts for your area, no Public Alerts cards will be displayed. Public Alerts will also show up in your notification shade when updates are available -- just swipe down from the top of your screen to open or dismiss these notifications.

	Source: (https://support.google.com/publicalerts/) Google Search Desktop and mobile searches trigger alerts when and where they are relevant for our users. The alerts information that you provide defines the area affected by an emergency or warning condition, and the severity of the event. Along with this information, factors that determine who will see the alert include the user's query and the location of the user's device. For example, a user who is outside the affected area described in the CAP data may need to enter a more detailed search query to see the alert than a user who is inside the affected area. The alert results in a warning that the user can click through to find out more information. Google Maps Google Maps displays geographic data to users on computers, tablets, and mobile phones. When searching an area in Maps on a desktop or a mobile app, nearby relevant alerts for that area appear. The mobile app also provides location based warning notifications for relevant alerts. Google Now Google Now provides active relevant alert notifications based on the device location. Notifications include a description of what's going on, the affected area, and possible actions to take in order to stay safe. **Source:** (https://developers.google.com/public-alerts/guides/introduction)

[1c] a crowd risk determinant to assess said aggregation of said current locations of said plurality of physical wireless devices pertaining to said potential viral event triggered by said network monitor.	The Google Public Alerts platform can alert wireless mobile devices of a viral event within a particular geographical area when the devices within that particular geographical area receive an alert associated with said viral event by monitoring Google's public alert data through a wireless network. Using data from authorized alert originators and distributors for each particular geographical area, risk can be determined. For a list of partners, see https://support.google.com/publicalerts/#3249690. The following exemplifies this limitation's existence in Accused Systems: **How does Google work with government agencies like the US National Weather Service?** Google partners with authorized alert originators and distributors listed here. For additional information about preparing Public Alerts data, please visit our Partner Help Center.

	I'm from a public agency and I'd love to see our alerts on Google Public Alerts. How do I make that happen? We welcome partnerships with agencies, domestic and international, who publish authoritative alerts. In order to get a head start, you can follow the steps below: • Get your alerts into the Common Alerting Protocol (CAP 1.2) standard. Here are some resources we created to help you with this process. Most commercial alert publishing tools support CAP already. • Validate that you've set-up your feeds correctly and that your CAP is correct. After performing the steps above please fill out this contact form. If Google is interested in integrating your data into public alerts, we will respond to your initial inquiry submitted through this form and schedule a call to talk with your organization. The purpose of the call is to allow us to better understand what content you are interested in bringing to Public Alerts. If we want to move forward with your organization and your data, we will proceed to a data evaluation stage. During this stage, we may request that you provide us with sample data, technical support from your team, and further information about your systems and process. In parallel, we will work with you on an agreement to disseminate your data. Once we evaluate your data, and if we determine that your data is a match for Public Alerts, we will continue to work with your team to integrate your data into Public Alerts. **Source:** (https://support.google.com/publicalerts/)

	Who can publish Google Public Alerts Partners who publish a Google Public Alert must be: • a public safety agency or a public alerts provider with information that affects people's life and property, and • the original and authoritative author of the alert information OR have rights from the original author to aggregate and/or distribute this information. All meteorological agencies should register with the WMO register of alerting authorities. In the U.S., we also prefer for our partners to be a certified IPAWS Public Alerting Authority.

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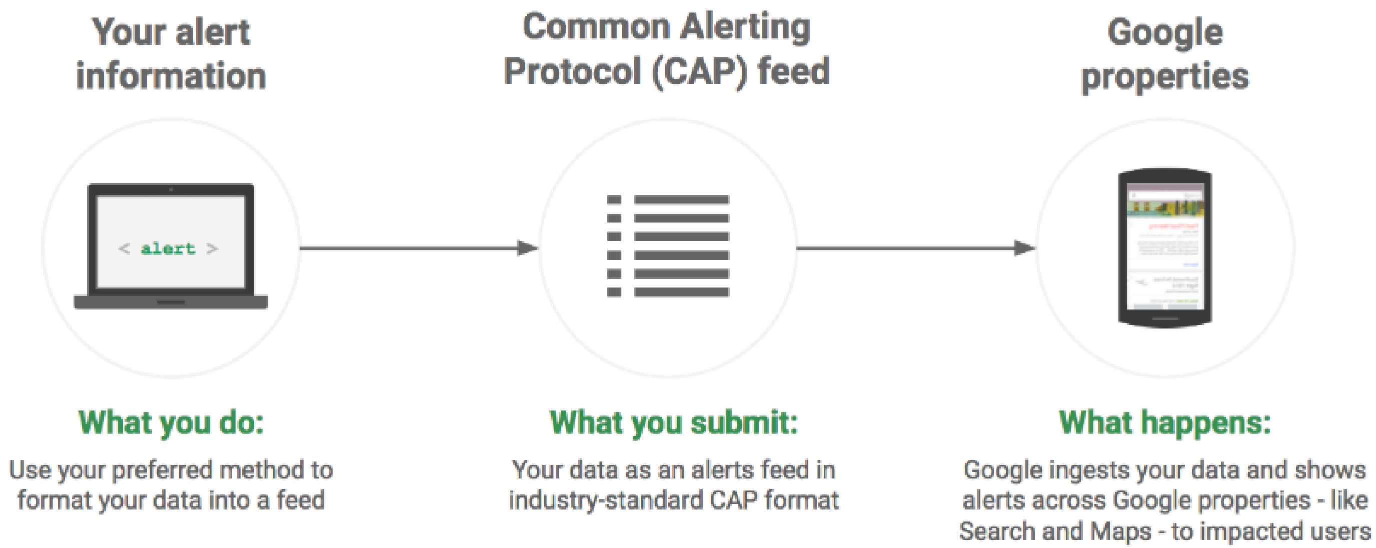

Source: (https://developers.google.com/public-alerts/guides/introduction)